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THE WILLAMETTE BASIN COMPREHENSIVE STUDY OF WATER AND RELATED L--ETC(U)
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WILLAMETTE BASIN

COMPREHENSIVE STUDY

Water and Related Land Resources

APPENDIX F

IRRIGATION

WILLAMETTE BASIN TASK FORCE - PACIFIC NORTHWEST RIVER BASINS COMMISSION

1969

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The WILLAMETTE BASIN

COMPREHENSIVE STUDY of

Water and Related Land Resources

APPENDIX F

IRRIGATION

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WILLAMETTE BASIN TASK FORCE - PACIFIC NORTHWEST RIVER BASINS COMMISSION

(11) 1969

(12) 175p.

CREDITS

This is one of a series of appendices to the Willamette Basin Comprehensive Study main report. Each appendix deals with a particular aspect of the study. The main report is a summary of information contained in the appendices plus the findings, conclusion, and recommendations of the investigation.

This appendix was prepared by the Irrigation Committee under the general supervision of the Willamette Basin Task Force. The committee was chaired by the Bureau of Reclamation and included representation from the agencies listed below.

Oregon State Water Resources Board
Oregon State University
Department of Agriculture

During the initial period of study, the Department of Health, Education, and Welfare, and the Oregon State Division of Planning and Development also participated.

ORGANIZATION

PACIFIC NORTHWEST RIVER BASINS COMMISSION

Columbia Basin Inter-Agency Committee until 1967

WILLAMETTE BASIN TASK FORCE

State of Oregon - Chairman	Commerce
Army	Labor
Agriculture	Federal Power Commission
Interior	Health, Education and Welfare

REPORT WRITER

TECHNICAL STAFF

Army	Interior
Agriculture	State

PLAN FORMULATOR

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A. Study Area	G. Land Measures and Watershed Protection
B. Hydrology	H. Municipal and Industrial Water Supply
C. Economic Base	I. Navigation
D. Fish and Wildlife	J. Power
E. Flood Control	K. Recreation
F. Irrigation	L. Water Pollution Control
	M. Plan Formulation

WILLAMETTE BASIN TASK FORCE

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Department of Interior	John F. Mangan Area Engineer, Lower Columbia Development Office Bureau of Reclamation
Department of Agriculture	Oke Eckholm Assistant State Conservationist Soil Conservation Service
Department of Commerce	David J. Bauman Hydrologist, Weather Bureau Forecast Center
Federal Power Commission	Gordon N. Boyer Hydraulic Engineer Federal Power Commission
Department of Labor	Horace Harding Regional Economist Bureau of Employment Security
Department of Health, Education & Welfare	Francis L. Nelson Public Health Service Water Supply and Sea Resources Program

The Willamette Basin Comprehensive Study has been directed and coordinated by the Willamette Basin Task Force, whose membership as of April 1969 is listed above. The Task Force has been assisted by a technical staff, a plan formulator, and a report writer - Executive Secretary. Appendix committees listed on the following page carried out specific technical investigations.

APPENDIX COMMITTEES

Appendix-Subject		
A - Study Area	OSWRB - Chairman:	FWPCA, USBPA, USBLM, USBM, USBOR, USBR, USBSF&WL, USCE, USERS, USFS, USGS, USNPS, USSCS, OSDC, OSDF, OSDG&MI, OSS&WCC, OSU
B - Hydrology	USGS - Chairman:	FWPCA, USBPA, USBR, USCE, USSCS, USWB, OSE, OSWRB
C - Economic Base	USCE - Chairman:	FWPCA, USBPA, USBCF, USBM, USBOR, USBR, USBSF&WL, USDL, USERS, USFS, OSDC, OSU, UO, PSC-PR&C
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E - Flood Control	USCE - Chairman:	FWPCA, USBR, USDA, USGS, USSCS, USWB, OSDC, OSE, OSWRB, UO
F - Irrigation	USBR - Chairman:	USSCS, OSDC, OSWRB, OSU
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H - M&I Water Supply	FWPCA - Chairman:	USBR, USBSF&WL, USGS, USSCS, OSBH, OSDC, OSWRB, USHEW
I - Navigation	USCE - Chairman:	OSDC, OSMB, POP, OSU
J - Power	USBPA - Chairman:	FPC, FWPCA, USBCF, USBR, USCE, USFS, USGS, OSE, OSWRB
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L - Water Pollution Control	FWPCA - Chairman:	USBCF, USBLM, USBOR, USBR, USBSF&WL, USGS, USSCS, OSBH, OSE, OSFC, OSGC, OSWRB, OSU, USHEW
M - Plan Formulation	Plan Formulator - Chairman:	USCE, USDA, USDI, OSWRB

FPC - Federal Power Commission
FWPCA - Federal Water Pollution Control Administration
USBPA - Bonneville Power Administration
USBCF - Bureau of Commercial Fisheries
USBLM - Bureau of Land Management
USBM - Bureau of Mines
USBOR - Bureau of Outdoor Recreation
USBR - Bureau of Reclamation
USBSF&WL - Bureau of Sport Fisheries and Wildlife
USCE - Corps of Engineers
USDA - Department of Agriculture
USHEW - Department of Health, Education and Welfare
USDI - Department of Interior
USDL - Department of Labor
USERS - Economic Research Service
USFS - Forest Service
USGS - Geological Survey
USNPS - National Park Service
USSCS - Soil Conservation Service
USWB - Weather Bureau

OSBH - Oregon State Board of Health
OSDC - Oregon State Department of Commerce
OSDF - Oregon State Department of Forestry
OSDG&MI - Oregon State Department of Geology and Mineral Industries
OSE - Oregon State Engineer
OSFC - Fish Commission of Oregon
OSGC - Oregon State Game Commission
OSHD-PD - Oregon State Highway Department - Parks Division
OSMB - Oregon State Marine Board
OSS&WCC - Oregon State Soil and Water Conservation Committee
OSWRB - Oregon State Water Resources Board
OSU - Oregon State University
PSC-PR&C - Portland State College - Center for Population Research and Census Service
UO - University of Oregon
LCPD - Land County Parks Department
OCPA - Oregon County Parks Association
POP - Port of Portland

BASIN DESCRIPTION

Between the crests of the Cascade and Coast Ranges in northwestern Oregon lies an area of 12,045 square miles drained by Willamette and Sandy Rivers--the Willamette Basin. Both Willamette and Sandy Rivers are part of the Columbia River system, each lying south of lower Columbia River.

With a 1965 population of 1.34 million, the basin accounted for 68 percent of the population of the State of Oregon. The State's largest cities, Portland, Salem, and Eugene, are within the basin boundaries. Forty-one percent of Oregon's population is concentrated in the lower basin subarea, which includes the Portland metropolitan area.

The basin is roughly rectangular, with a north-south dimension of about 150 miles and an average width of 75 miles. It is bounded on the east by the Cascade Range, on the south by the Calapooya Mountains, and on the west by the Coast Range. Columbia River, from Bonneville Dam to St. Helens, forms a northern boundary. Elevations range from less than 10 feet (mean sea level) along the Columbia, to 450 feet on the valley floor at Eugene, and over 10,000 feet in the Cascade Range. The Coast Range attains elevations of slightly over 4,000 feet.

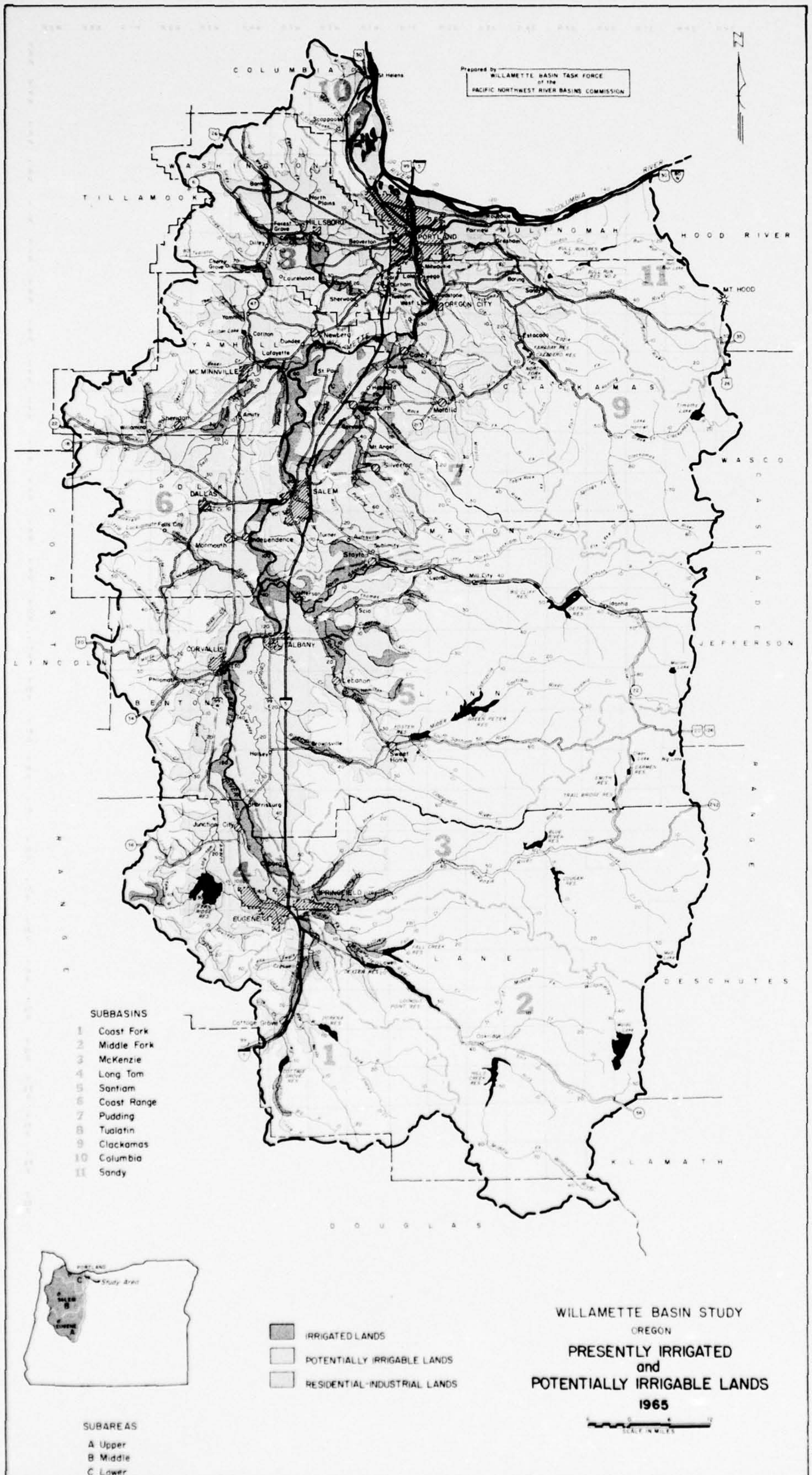
The Willamette Valley floor, about 30 miles wide, is approximately 3,500 square miles in extent and lies below an elevation of 500 feet. It is nearly level in many places, gently rolling in others, and broken by several groups of hills and scattered buttes.

Willamette River forms at the confluence of its Coast and Middle Forks near Springfield. It has a total length of approximately 187 miles, and in its upper 133 miles flows northward in a braided, meandering channel. Through most of the remaining 54 miles, it flows between higher and more well defined banks unhindered by falls or rapids, except for Willamette Falls at Oregon City. The stretch below the falls is subject to ocean tidal effects which are transmitted through Columbia River.

Most of the major tributaries of Willamette River rise in the Cascade Range at elevations of 6,000 feet or higher and enter the main stream from the east. Coast Fork Willamette River rises in the Calapooya Mountains, and numerous smaller tributaries rising in the Coast Range enter the main stream from the west.

In this study, the basin is divided into three major sections, referred to as the Upper, Middle, and Lower Subareas (see map opposite). The Upper Subarea is bounded on the south by the Calapooya Mountains and on the north by the divide between the McKenzie River drainage and the Calapooia and Santiam drainages east of the valley floor and by the Long Tom-Marys River divide west of it. The Middle Subarea includes all lands which drain into Willamette River between the mouth of Long Tom River and Fish Eddy, a point three miles below the mouth of Molalla River. The Lower Subarea includes all lands which drain either into Willamette River from Fish Eddy to its mouth or directly into Columbia River between Bonneville and St. Helens; Sandy River is the only major basin stream which does not drain directly into the Willamette.

For detailed study, the three subareas are further divided into 11 subbasins as shown on the map.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COLUMBIA
TILLAMOOK
MULTNOMAH
HOOD RIVER
MT. HOOD
PORTLAND
HILLSBORO
OREGON CITY
YAMHILL
McMINNVILLE
CLACKAMAS
WASCO
POLK
DALLAS
SALEM
MARION
CORVALLIS
ALBANY
BENTON
LINCOLN
LINN
JEFFERSON
LANE
EUGENE
SPRINGFIELD
DESCHUTES
KLAMATH
DOUGLAS
COAST RANGE
CASCADE RANGE
SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS
WILLAMETTE BASIN STUDY
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A Upper
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(Some Titles Abridged)

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this appendix is to appraise the present irrigation development, outline the irrigation potential, and present recommendations for the orderly and efficient development of irrigation within the basin. These findings are used in formulation studies to develop the overall comprehensive plan for water and related land resources in the basin.

This appendix is essentially single-purpose in scope. Projections of irrigation development are given for the years 1980, 2000, and 2020. Single-purpose means to achieve irrigation objectives are also given. These analyses are made on the assumption that there will be ample water for full irrigation development.

The data presented are generally of a reconnaissance level to give a broad-scaled analysis of future requirements for development of irrigation in the basin. More detailed data are presented in those instances where the need identified is of a more immediate nature and will warrant specific action within the readily foreseeable future.

RELATIONSHIP TO OTHER PARTS OF REPORT

This appendix relies upon supporting data contained in the three supporting appendices, A - Study Area, B - Hydrology, and C - Economic Base. It is related more specifically to some of the functional appendices, and data developed in this and other appendices are used interchangeably as required. Irrigation is related very closely to drainage (see Appendix G - Land Measures and Watershed Protection) not only in that it alters the balance of runoff from farmlands but also in that severe drainage deficiencies limit the irrigation potential of the lands. Because of the extent to which electric power is used to operate both on-farm and project irrigation pumps, the level of irrigation development has a direct influence on basin power requirements. Fish and wildlife habitat and water quality are influenced by the amount and kind of irrigation diversions and return flow. Also expansion of irrigated acreage may change the balance of wildlife populations.

The relationship of irrigation to all other functions of multipurpose water resource development is covered in detail in Appendix M - Plan Formulation. Data contained in the Irrigation Appendix are used in the plan formulation studies and to provide a background for the irrigation aspects of the main report.

H I S T O R Y

"The need of irrigation in Willamette Valley is apparent to anyone who visits the region in July and August." This is a quotation from the 1916 report on Willamette Valley irrigation, published cooperatively by the U.S. Reclamation Service and the State of Oregon (Whistler and Lewis, p. 70). Although the valley receives about 40 inches of precipitation annually, only about 9 inches occur during the April through September growing season, which is insufficient moisture for best growth of many crops. For example, the average growing season consumptive-use requirement of irrigated pasture is about 30 inches.

The dry summer climatic regimen of Western Oregon has had a profound effect on the Willamette Valley's agricultural history. Under dryland conditions, farmers either raised early-maturing or drought-resisting crops, or obtained somewhat limited yields of other crops. This situation has resulted in considerable acreage being devoted to crops which are widely adapted to other areas of the United States and which have been in surplus nationally. In those parts of the valley where irrigation has been practiced, significant changes have taken place. Farmers have greater freedom of choice as to what crops can be grown. On some lands, there has been a switchover to high-value row crops supporting local cannery and processing industries. On other lands, yields of crops previously dry-farmed have been greatly increased.

The earliest known instance of commercial irrigation in the Willamette Basin dates back to 1890. Prior to that time, some family gardens had been irrigated from the domestic water supply. In the 1890's and early 1900's, a few acres of truck vegetables for the fresh market were irrigated. Most of this early irrigation took place near the cities of Portland, Salem, and Eugene.

GROWTH OF IRRIGATION

Irrigation development in the basin proceeded rather slowly through the first four decades of this century. About 1,000 acres were irrigated by 1911, 3,000 acres by 1920, 5,000 acres by 1930, and 27,000 acres by 1940. The first period of significant growth came in the late 1930's during the recovery period after the depression. During World War II, acreage under irrigation remained almost static, due largely to shortages of metal for sprinkler pipe systems, which have been used almost exclusively on newly irrigated lands since the 1930's. Since World War II, the growth of Willamette Valley irrigation has been spectacular (Figure I-1).

CROPS IRRIGATED

Early U.S. censuses of agriculture do not give a complete enumeration of irrigated crops. However, they indicate that livestock feeds were the main crops produced with early irrigation. The trend has been toward the production of more intensive crops and today livestock feeds and specialty crops are the major irrigated land uses.

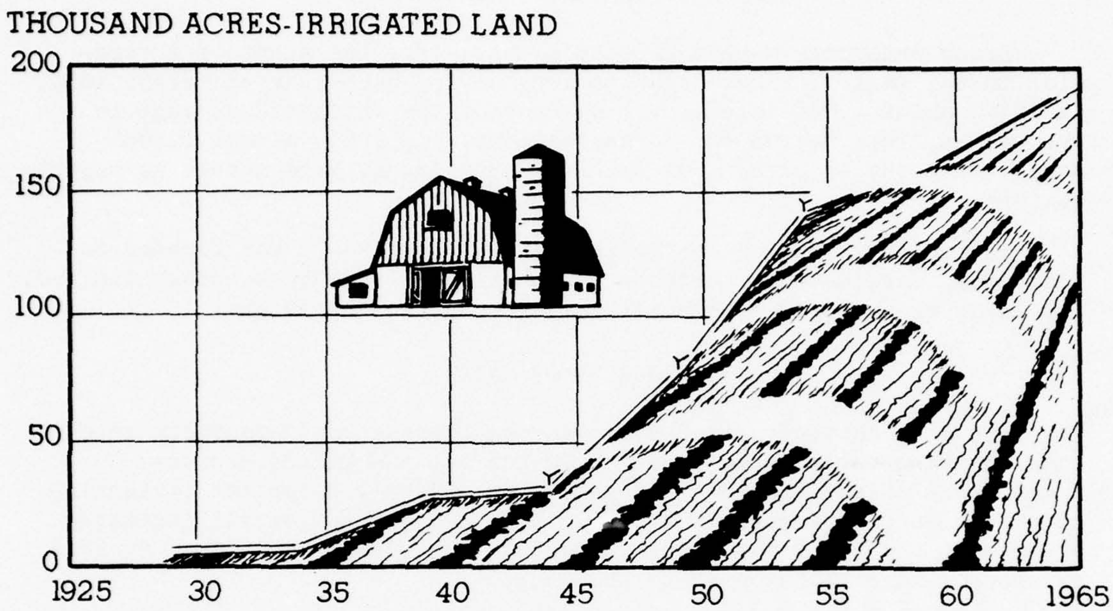


Figure I-1. Growth of Irrigation (U.S. Census of Agriculture, 1964)

Irrigation is extremely important to both the quality and quantity of many vegetables and fruits produced in the basin. Food processors are aware of this and as a matter of policy have instituted requirements to insure high quality products. In recent years, vegetables and berries raised under irrigation have become the basis for development of local processing industries.

METHODS OF WATER APPLICATION

Early irrigation in the Willamette Valley was almost entirely by gravity application and continued to be so until the 1930's. As irrigation development began to accelerate, sprinkler irrigation became relatively more important. In 1939, about half the acreage irrigated was by sprinkler; by 1949, the proportion was over three-fourths; by 1964, sprinklers were used on about 95 percent of the irrigated land.

Sprinkler irrigation with portable pipe, quick couplers, and rotary sprinklers originated in the Willamette Basin. Its wide acceptance here can be traced to a combination of factors. Comparatively low power cost in the valley and the development of low cost, light weight pipe have been instrumental in promoting use of sprinklers. Other advantages include; less specialized labor required, better control of water, and expensive land leveling operations eliminated. Farmers apparently believe these are sufficient inducements to choose this method of application.

TYPES OF IRRIGATION ENTERPRISE

Group enterprises have existed almost since the start of irrigation in the valley, three organizations having been started before 1910. In 1949, about 4,000 acres, or 5 percent of the irrigated acreage in the valley, were served from organizations. By 1964, almost 23,000 acres, or about 10 percent of the irrigated lands, were served by organizations.

The great expansion beginning in the later 1930's was founded on individual development. Cooperative development has been rather limited, but it is expected to become more significant in the future.

SOURCES OF WATER

The 1950 Agricultural Census was the first to differentiate acreages deriving their water supply from surface and ground sources. Early reports indicate that before 1930 nearly all water for irrigation came from surface sources. In 1949, about 73 percent of all irrigated acreage in the basin was receiving water from surface sources. By 1964, this percentage had dropped to about 58.

As recognition of the value of irrigation became widespread, farmers who were faced with high costs in developing surface sources of water sought ground water to irrigate their lands; this accounts in part for the increasing importance of ground-water irrigation. Most of the irrigated acreage depending on ground water is found on the recent alluvium near the Willamette River and its major tributaries and in a few areas of older bench soils such as in French Prairie, north of Salem. In most other parts of the basin, yields from wells have not been sufficient for irrigation to develop to any great extent.

Potentials for future irrigation expansion based on ground-water sources are limited by geologic conditions. Some areas could sustain increased ground-water development, but a large portion of the remaining nonirrigated cropland is located where adequate quantities for irrigation are not available.

Even though there is little unappropriated natural flow presently available during the irrigation season, most of the future expansion will probably be based on the use of surface sources. There is storage assigned to irrigation in each of the existing and authorized Federal reservoirs in the basin. Also, there is opportunity to obtain additional irrigation water supplies from surface sources through the further development of storage.

SURFACE IRRIGATION - GRAVITY FLOW

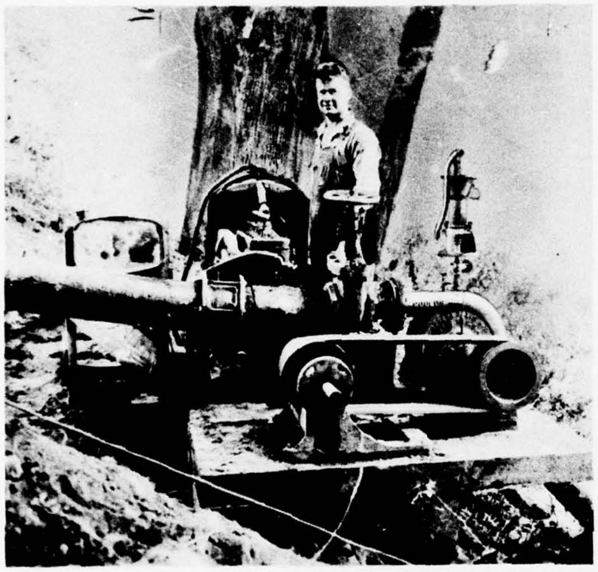
Photos from Special Report 197, Oregon State University.

Early irrigation in the Willamette Valley was almost entirely by gravity application and continued to be so until the early 1930's as illustrated on this farm near Sheridan.

Before the advent of portable sprinkler equipment, pioneering farmers in the Willamette Valley irrigated as best they could. Flood irrigation was used on this walnut orchard in 1933 to bring it into profitable production.

IRRIGATION PUMPING PLANT - POWER SOURCE

Photos from Special Report 197, Oregon State University.



In many areas, interest in irrigation preceded the availability of electricity to power pumps. In 1932, this Hillsboro dairyman installed a used car engine to lift 750 gallons per minute from the Tualatin River.

By 1940, electric power was available to most areas of concentrated irrigation. This farm near Junction City was one of many hundred such farms installing pumping equipment.

PRESENT STATUS

PRESENT STATUS

Irrigation, although relatively new on the agricultural scene, has increased rapidly, paralleling the basin's climb to occupy a position of national prominence in fruit and vegetable production.

Even though the growth of irrigation has been extensive, the potential is relatively untapped. With abundant excellent quality water supplies, fertile lands, and a climate conducive for production of a variety of crops, the future of irrigation in the basin is highly favorable.

Optimum irrigation development, here as in most areas, is confronted by problems, largely in the form of physical and economic limitations. One of the more common problems in the valley is excessive wetness brought on by heavy winter rains and relatively tight soils. However, this problem is being resolved through the installation of adequate drainage facilities. Most other problems can be resolved as well through appropriate physical, institutional, social, and legal measures.

Interest in project irrigation development has increased rapidly in recent years. Several Federal agencies are participating in multipurpose project investigations. The Bureau of Reclamation and Soil Conservation Service have the primary responsibility for irrigation planning, and each has a number of projects in various stages of investigation.

PRESENT DEVELOPMENT

Irrigation is in an early stage of development in the basin. It makes only a minor demand on the basin's total water resources, but constitutes a substantial part of the agricultural economy. In addition to readily available water and suitable land, there are several factors which have encouraged irrigation development -- the example of successful irrigators, economic incentives and potential cropping alternatives, and public educational programs have had their influence in bringing about a desire to irrigate. These factors operate irrespective of whether farmers develop irrigation individually or cooperatively.

Climatically, the basin is suitable for growth of many crops without irrigation, and dryland agriculture is firmly established. Therefore, the prospective irrigator must be assured that irrigation will return more profit than dry farming, in addition to amortizing the irrigation investment.

The testimony of successful irrigators has probably had the greatest influence on development attained thus far. It has induced many dryland farmers to switch to irrigation.

The future cropping pattern is another important consideration. If farmers adopt irrigation, there is a need to know which crops and enterprises can be introduced; the changes in investment and labor required; and which crops offer the best prospect for return. Oregon State University, County Extension Agents, Soil Conservation Service, and experimental farms have provided valuable information and assistance to farmers in answering these questions and inworking out plans.

If the farmer desires to irrigate, normally the opportunities for individual development are explored first. Most of the lands irrigated to date have been developed in this manner. The most important advantages are that less time is required to develop the irrigation system and that the farmer retains independence. However, individual development is practical only where water is readily available, such as along streams and in areas with adequate ground water.

Group development normally takes place where individual development is not physically practical or economically feasible. Farmers located away from surface - or ground-water sources are more likely to band together for the purpose of obtaining an irrigation project. Examples are in the Monmouth-Dallas, Red Prairie, Tualatin, and McKay Creek-Rock Creek areas.

IRRIGATED LAND

The irrigated acreage in Willamette Valley varies from year to year, and the location and pattern on each irrigated farm may vary with each irrigation season. Estimates of irrigated acreage by the Department of Commerce (U.S. Agricultural Census)indicate that 188,323 acres were irrigated in 1964. A field survey of irrigation conducted by the Bureau of Reclamation during the period 1964 through 1966 showed 243,660 acres irrigated. Data thus obtained are considered representative of development as of the 1965 irrigation season. The location of irrigated land was determined by field inspection and, insofar as possible, from interviews with farmers. Lands mapped as irrigated include those which received water during the year in which they were mapped. Acreage data by section, township, county, and subbasin are on file at the Bureau of Reclamation office in Salem. Table II-1 lists, by subbasin, the irrigated acreages determined from the field survey. The frontispiece shows the general location of both irrigated and potentially irrigable lands in Willamette Basin; Maps II-1 through II-11 show specific locations in each of the 11 subbasins.

Table II-1
Irrigated Acreage, 1965

Subbasin	Acres
1 - Coast Fork	3,470
2 - Middle Fork	2,090
3 - McKenzie	7,820
4 - Long Tom	20,730
5 - Santiam	54,810
6 - Coast Range	43,970
7 - Pudding	72,750
8 - Tualatin	19,090
9 - Clackamas	6,330
10 - Columbia	10,760
11 - Sandy	1,840
Willamette Basin	243,660

Source: USBR survey of irrigation

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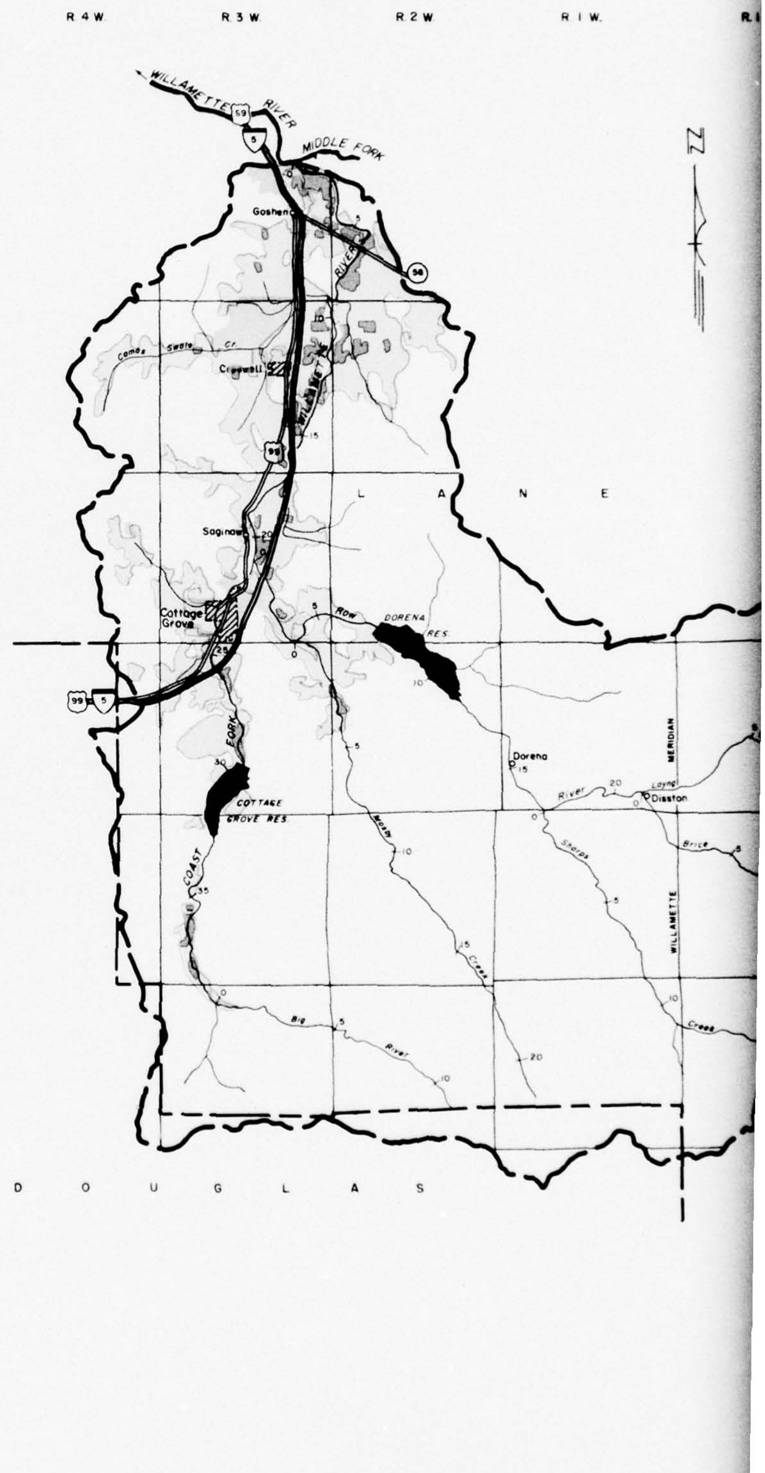
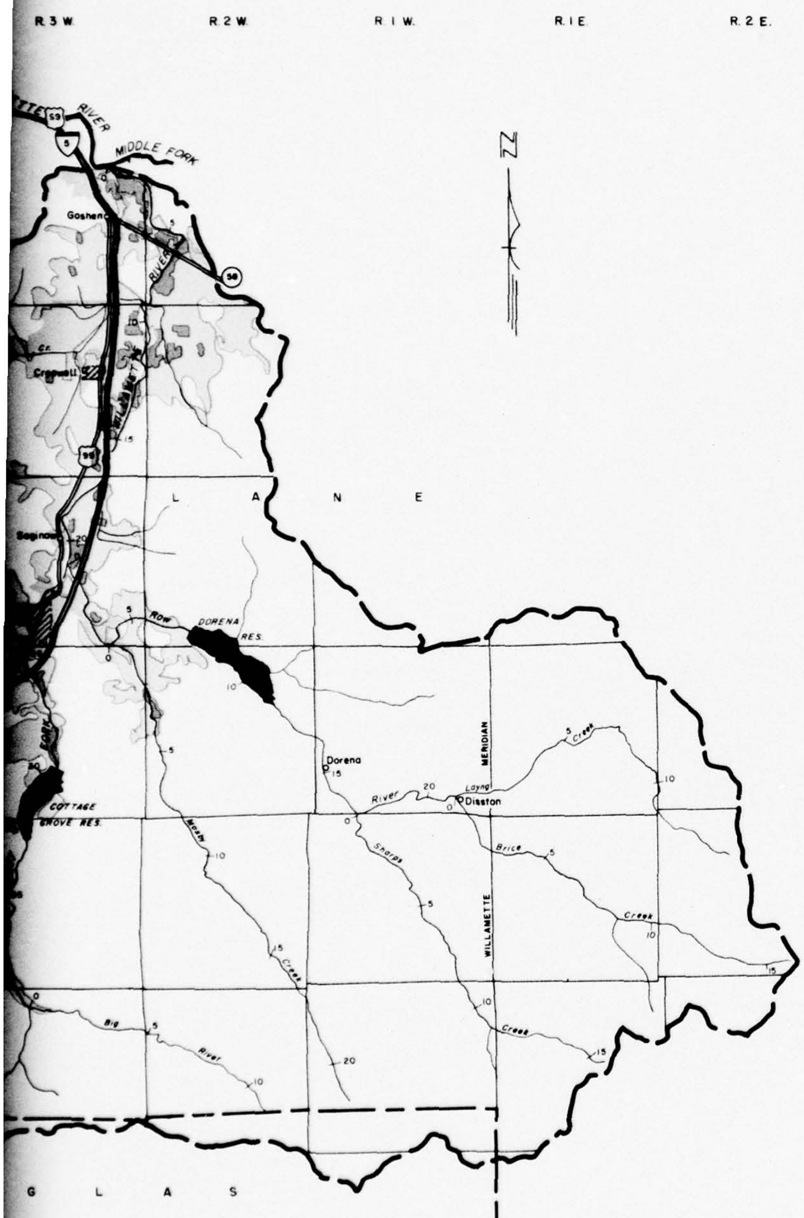
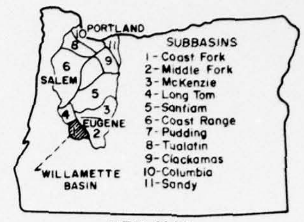






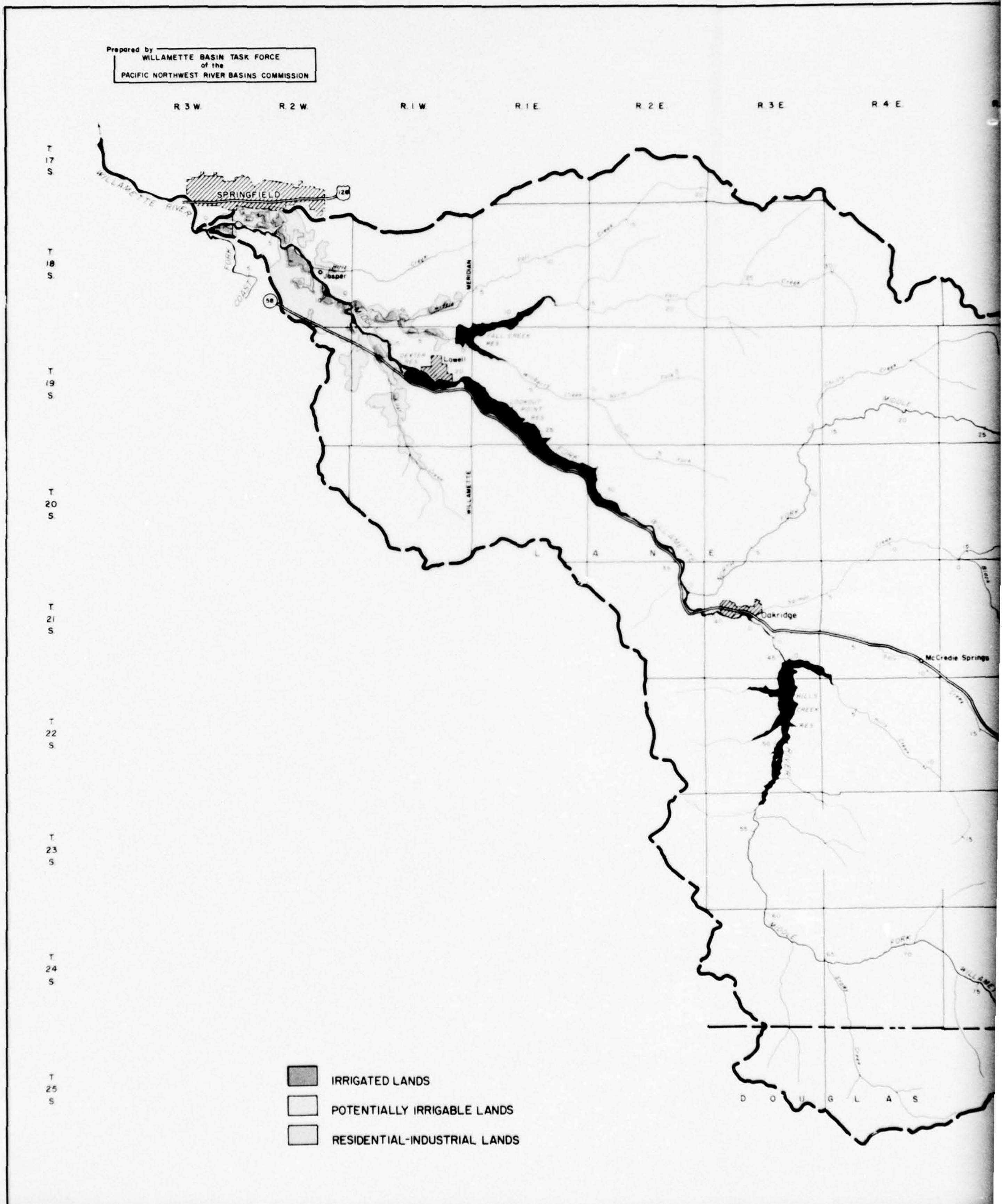
KEY MAP
SHOWING SUBBASINS

MAP II-1
COAST FORK
WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

SCALE IN MILES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R 2 W.
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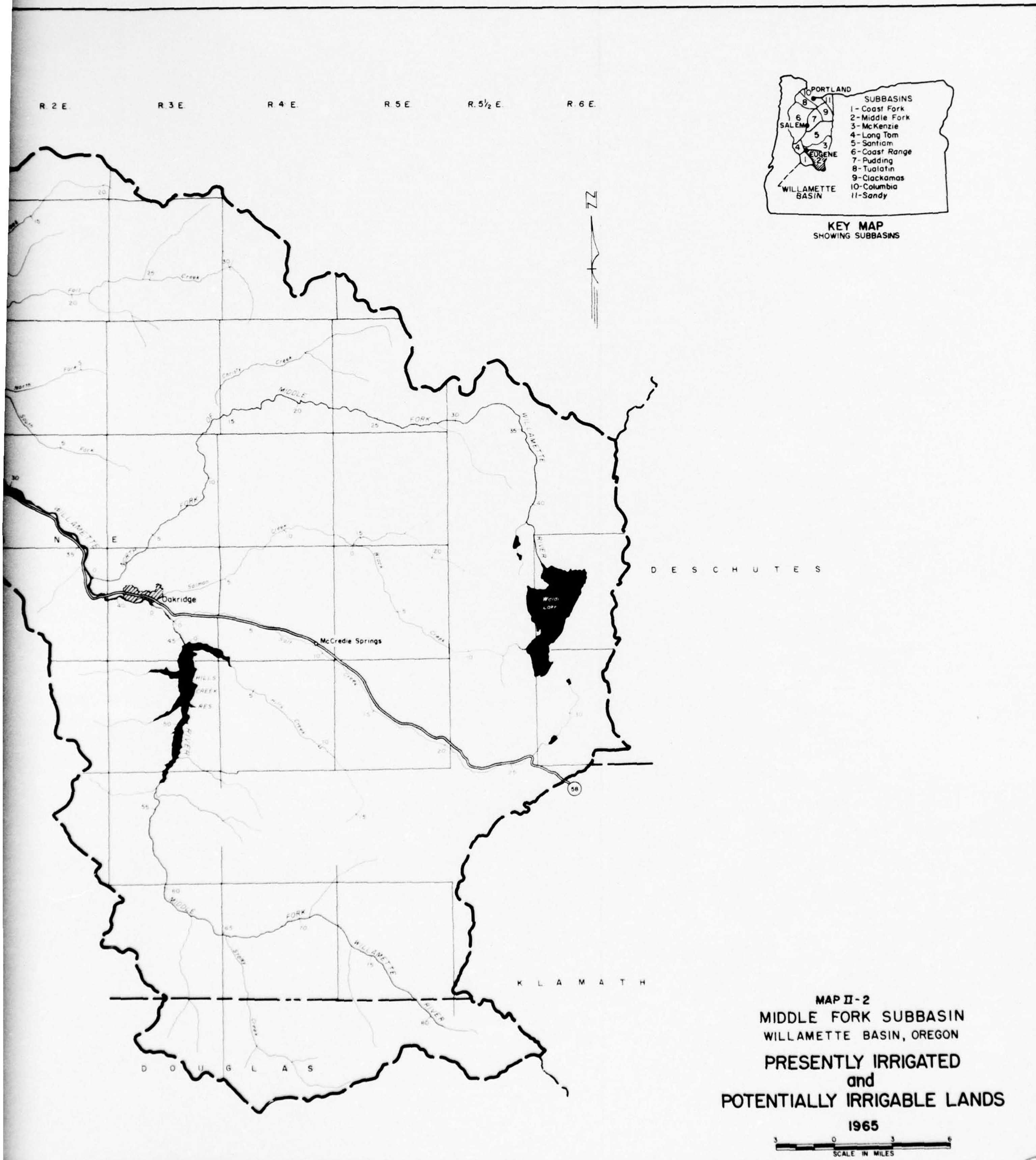
R 2 E.
R 3 E.
R 4 E.
T. 17 S.
T. 18 S.
T. 19 S.
T. 20 S.
T. 21 S.
T. 22 S.
T. 23 S.
T. 24 S.
T. 25 S.
WILLAMETTE RIVER
SPRINGFIELD
126
Jasper
58
COAST
FORK
MERIDIAN
WILLAMETTE
FALL CREEK RES
Lowell
Oakridge
McCredie Springs
HILLS CREEK RES
MIDDLE
FORK
L A N E
D O U G L A S
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS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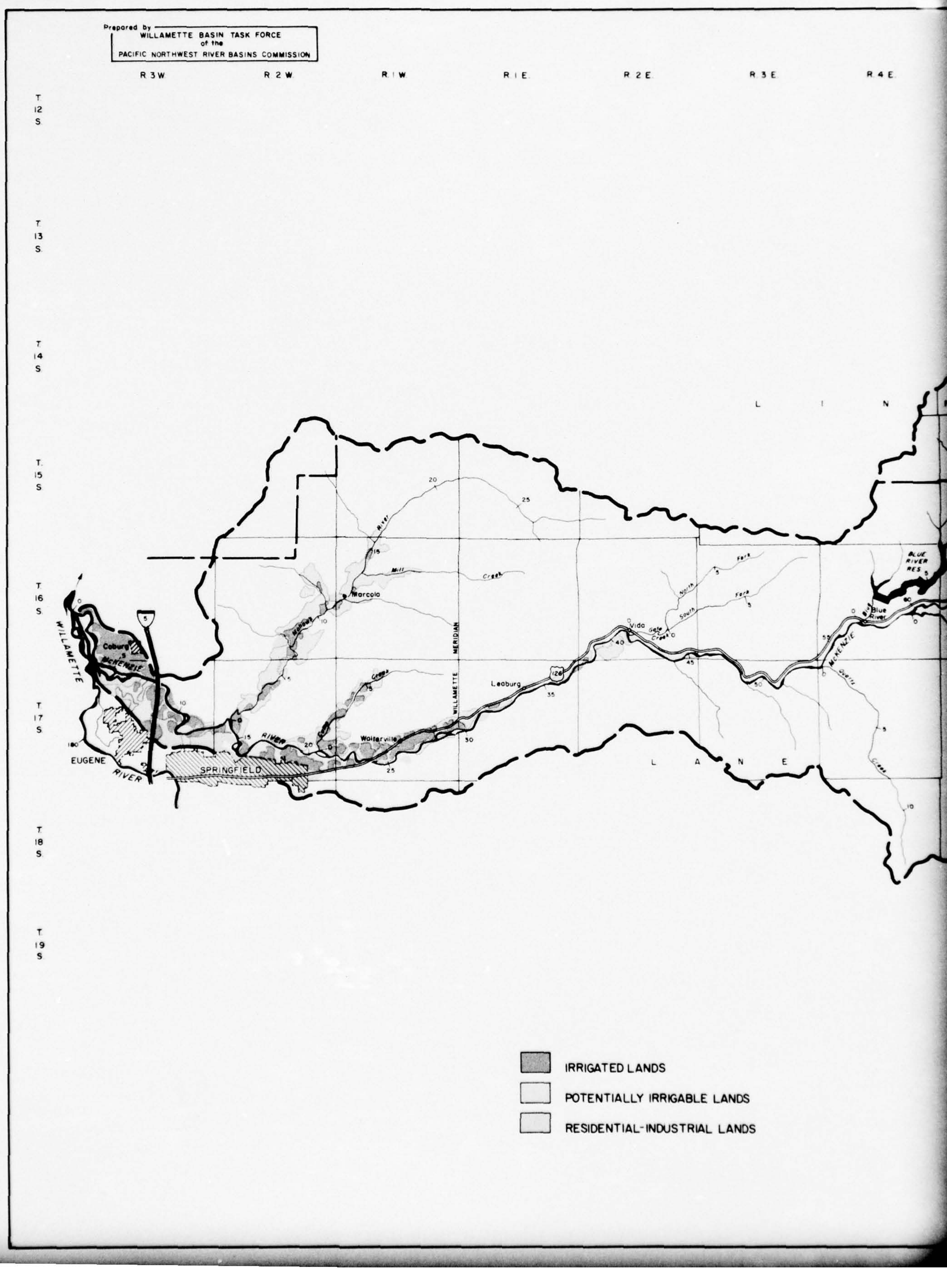
R. 3 E.
R. 4 E.
R. 5 E.
R. 5½ E.
R. 6 E.
PORTLAND
SALEM
EUGENE
WILLAMETTE BASIN
SUBBASINS
1 - Coast Fork
2 - Middle Fork
3 - McKenzie
4 - Long Tom
5 - Santiam
6 - Coast Range
7 - Pudding
8 - Tualatin
9 - Clackamas
10 - Columbia
11 - Sandy
KEY MAP
SHOWING SUBBASINS
N
MIDDLE FORK WILLAMETTE RIVER
WILLAMETTE
Oakridge
McCredie Springs
HILLS CREEK RES.
Waldo Lake
58
D E S C H U T E S
K L A M A T H
D O U G L A S
MAP II - 2
MIDDLE FORK SUBBASIN
WILLAMETTE BASIN, OREGON
PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS
1965
SCALE IN MILES



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R 2 W.
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T. 12 S.
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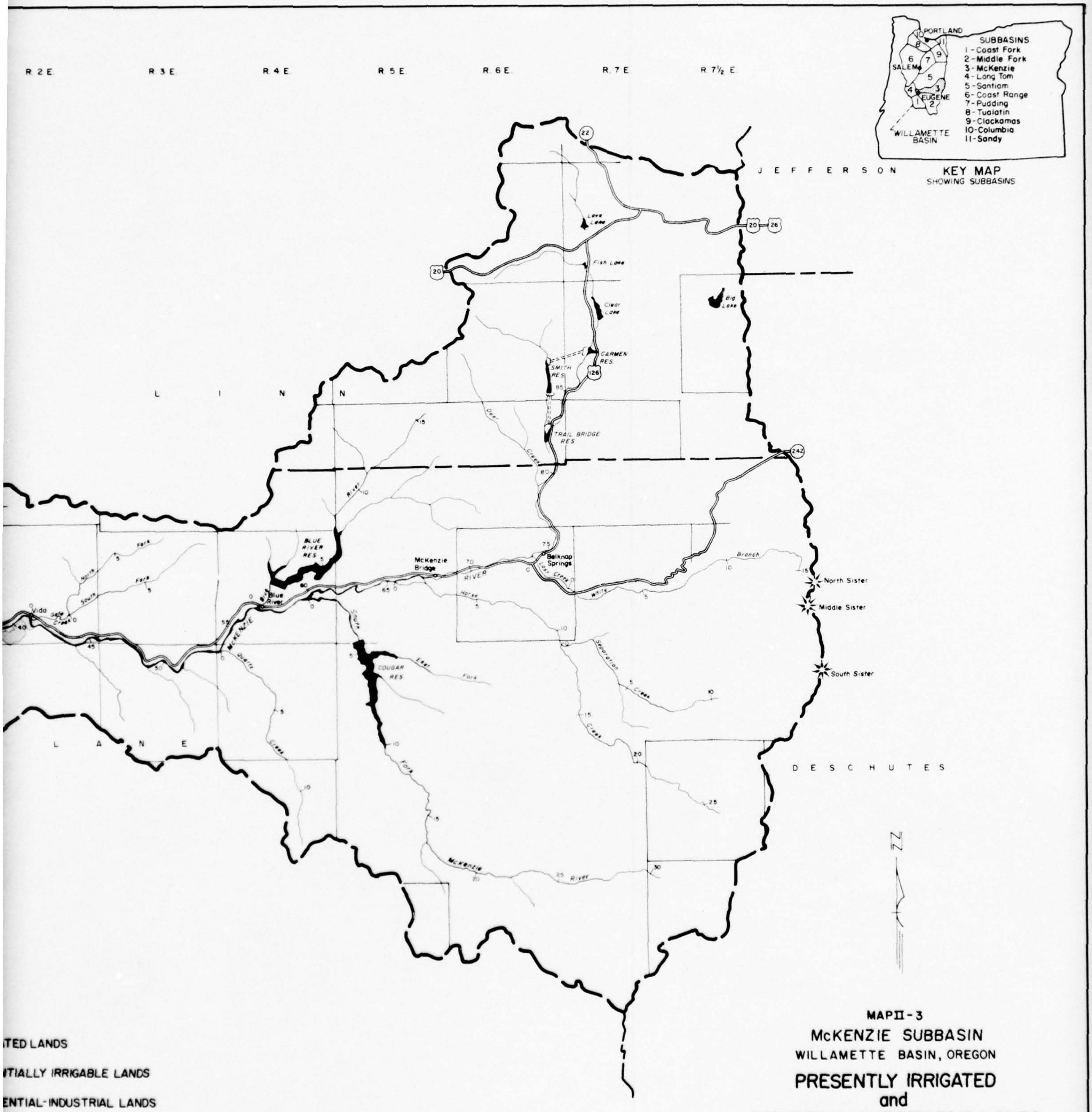
T. 15 S.
T. 16 S.
T. 17 S.
T. 18 S.
T. 19 S.
L I N N
L A N E
WILLAMETTE
Coburg
McKENZIE
EUGENE
RIVER
SPRINGFIELD
Marcola
Mill
Creek
Walterville
Leaburg
WILLAMETTE MERIDIAN
Vida
Gate Creek
North Fork
South Fork
Blue River
BLUE RIVER RES.
McKENZIE
Quartz Creek
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



ATED LANDS

NTIALLY IRRIGABLE LANDS

ENTIAL-INDUSTRIAL LANDS

MAP II-3

McKENZIE SUBBASIN

WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED and POTENTIALLY IRRIGABLE LANDS

1965

WBTF-3-1026 d-LL

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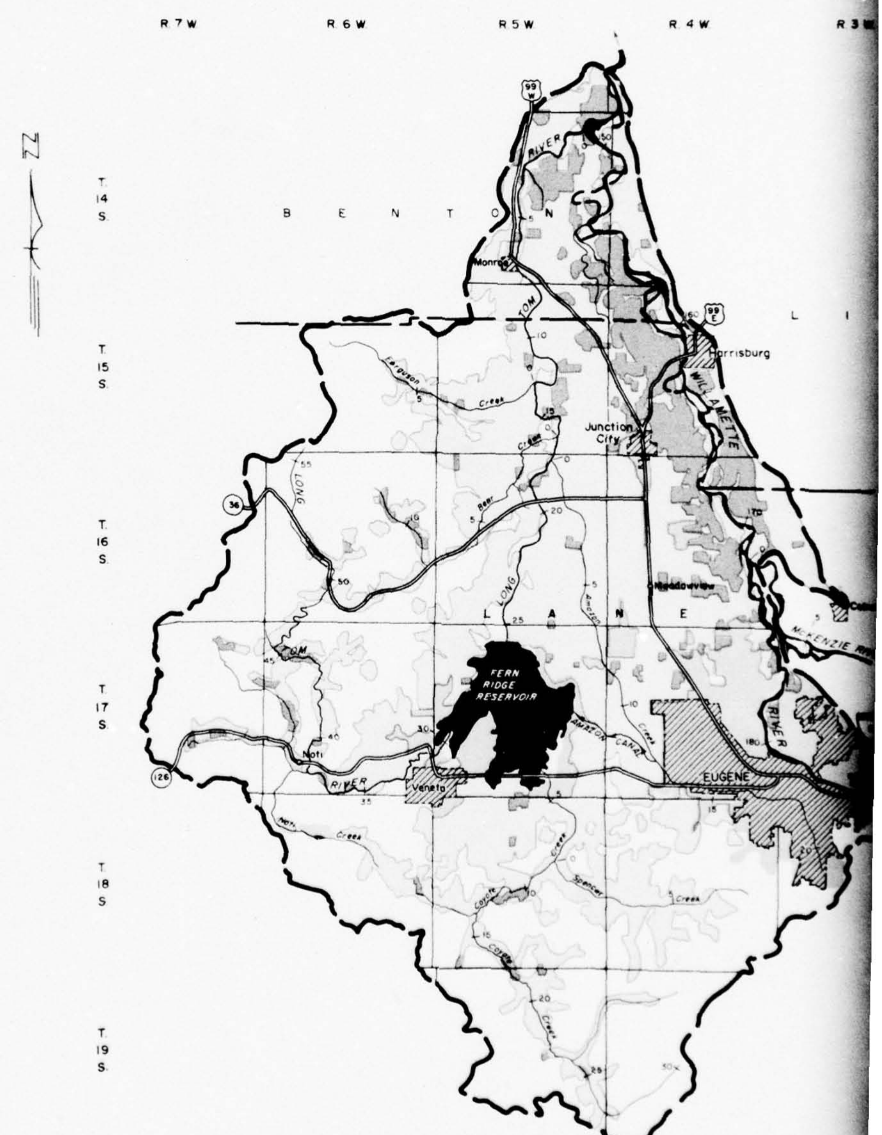
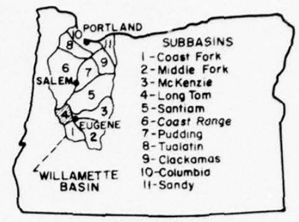


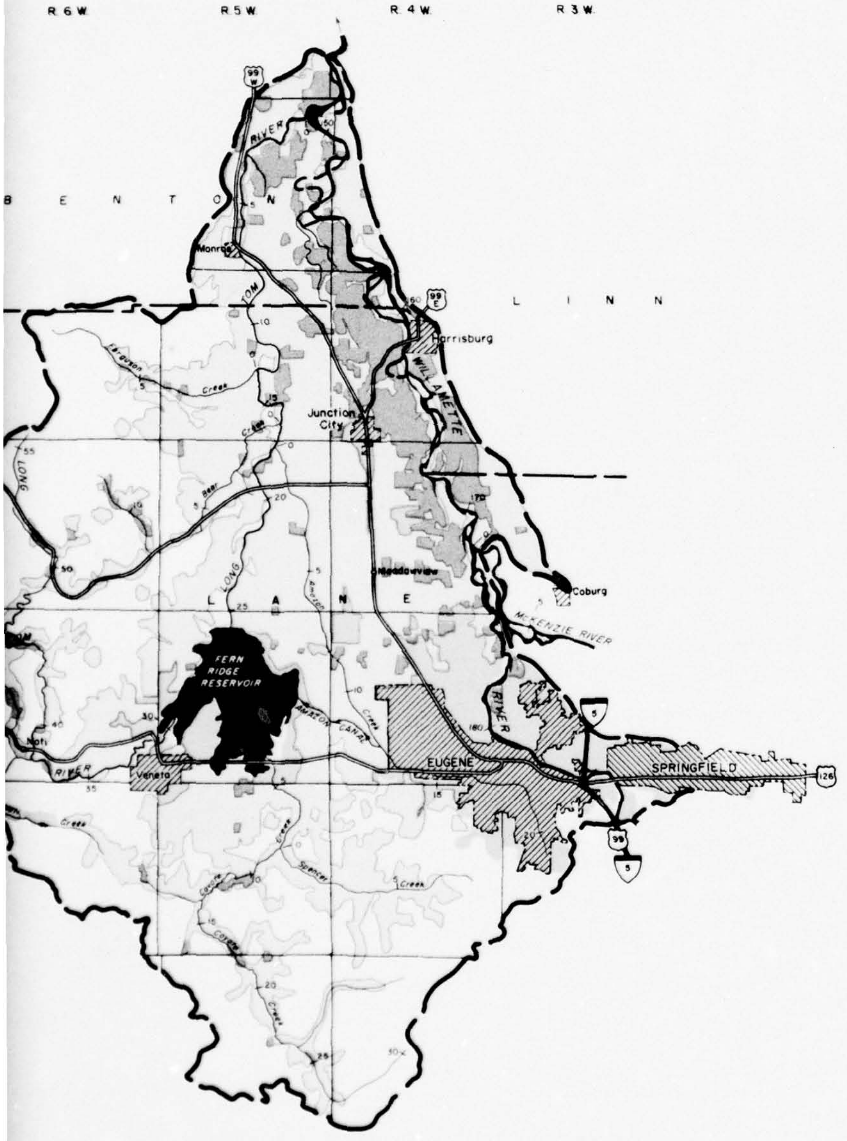
IRRIGATED LANDS

POTENTIALLY IRRIGABLE LANDS

RESIDENTIAL-INDUSTRIAL LANDS



KEY MAP
SHOWING SUBBASINS



MAP II - 4

LONG TOM SUBBASIN
WILLAMETTE BASIN, OREGON

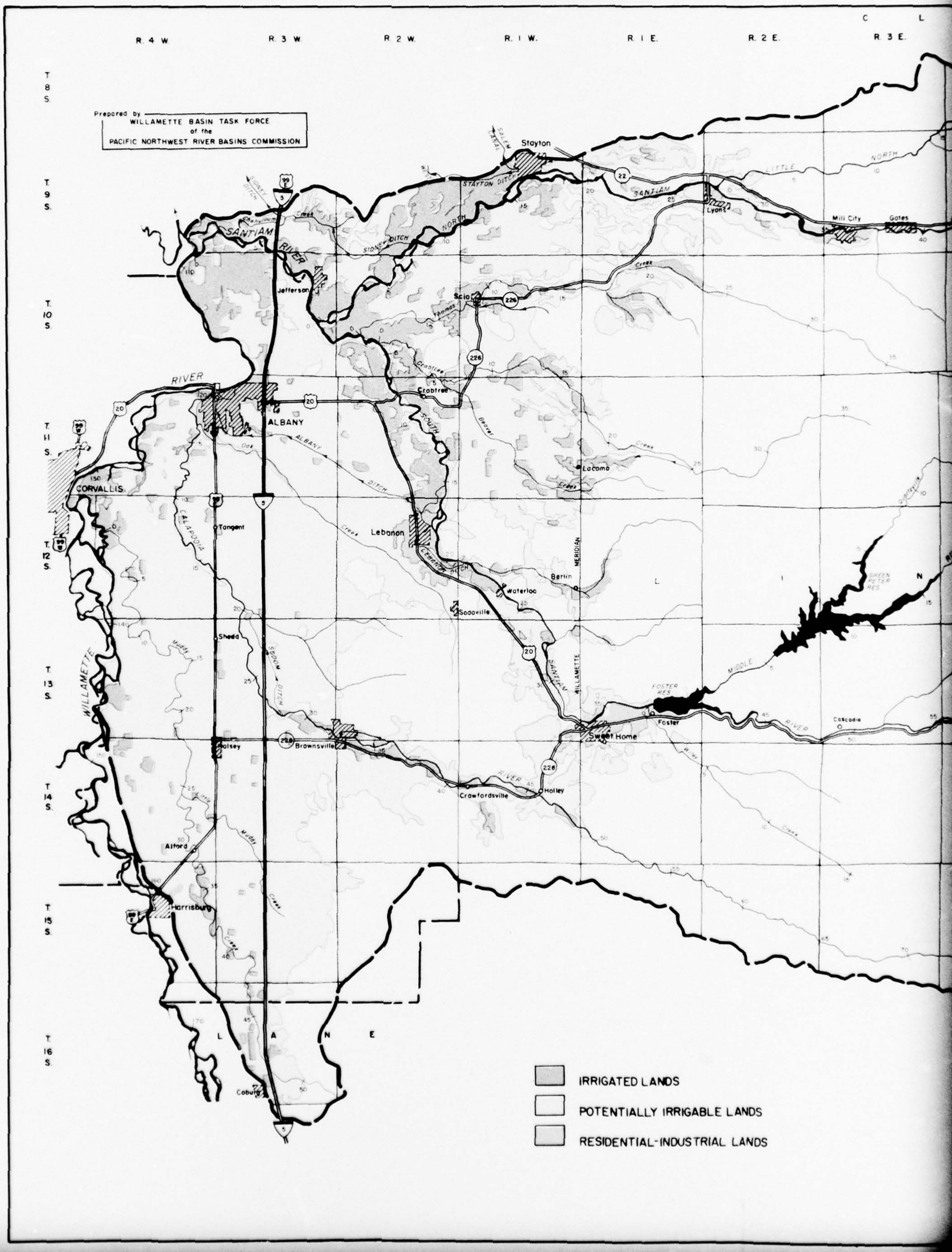
PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

3 0 3 6
SCALE IN MILES

2

WBTF-4-1027 d-LL



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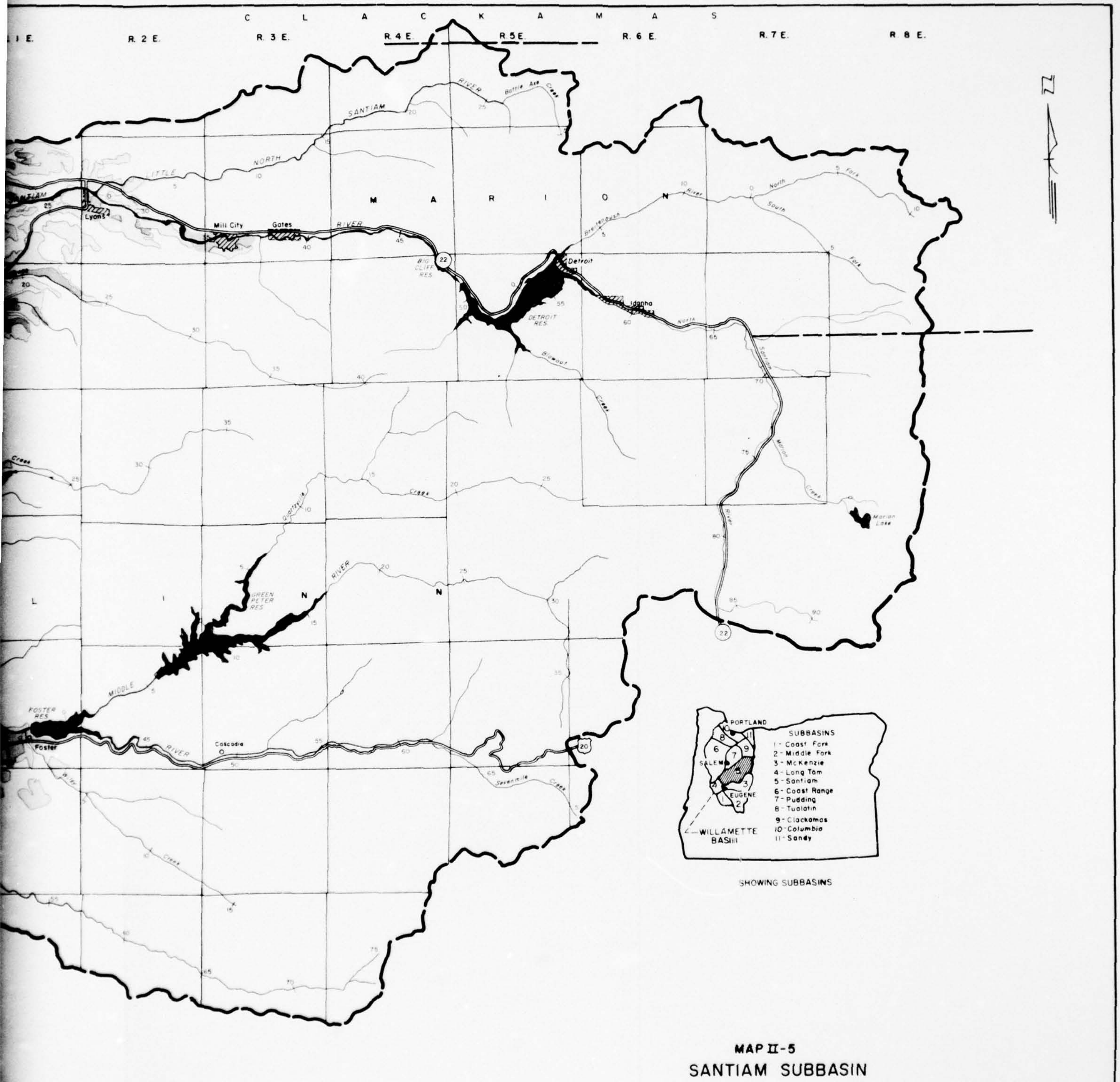
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
T. 8 S.
T. 9 S.
T. 10 S.
T. 11 S.
T. 12 S.
T. 13 S.
T. 14 S.
T. 15 S.
T. 16 S.
Stayton
Lyons
Mill City
Gates
Jefferson
Scio
ALBANY
Crabtree
CORVALLIS
Lacomb
Tangent
Lebanon
Berlin
Waterloo
Sodaville
Shedd
Halsey
Brownsville
Sweet Home
Foster
Cascadia
Crawfordsville
Holley
Alford
Harrisburg
Coburg
SANTIAM RIVER
NORTH SANTIAM
LITTLE NORTH
STAYTON DITCH
SIDNEY DITCH
ALBANY DITCH
LEBANON DITCH
SODOM DITCH
SOUTH SANTIAM
MIDDLE
RIVER
WILLAMETTE
CALAPOOIA
WILLAMETTE MERIDIAN
FOSTER RES.
GREEN PETER RES.
L A N E
L I N N
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



MAP II-5

SANTIAM SUBBASIN

WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED and POTENTIALLY IRRIGABLE LANDS

1965

3 0 3 6

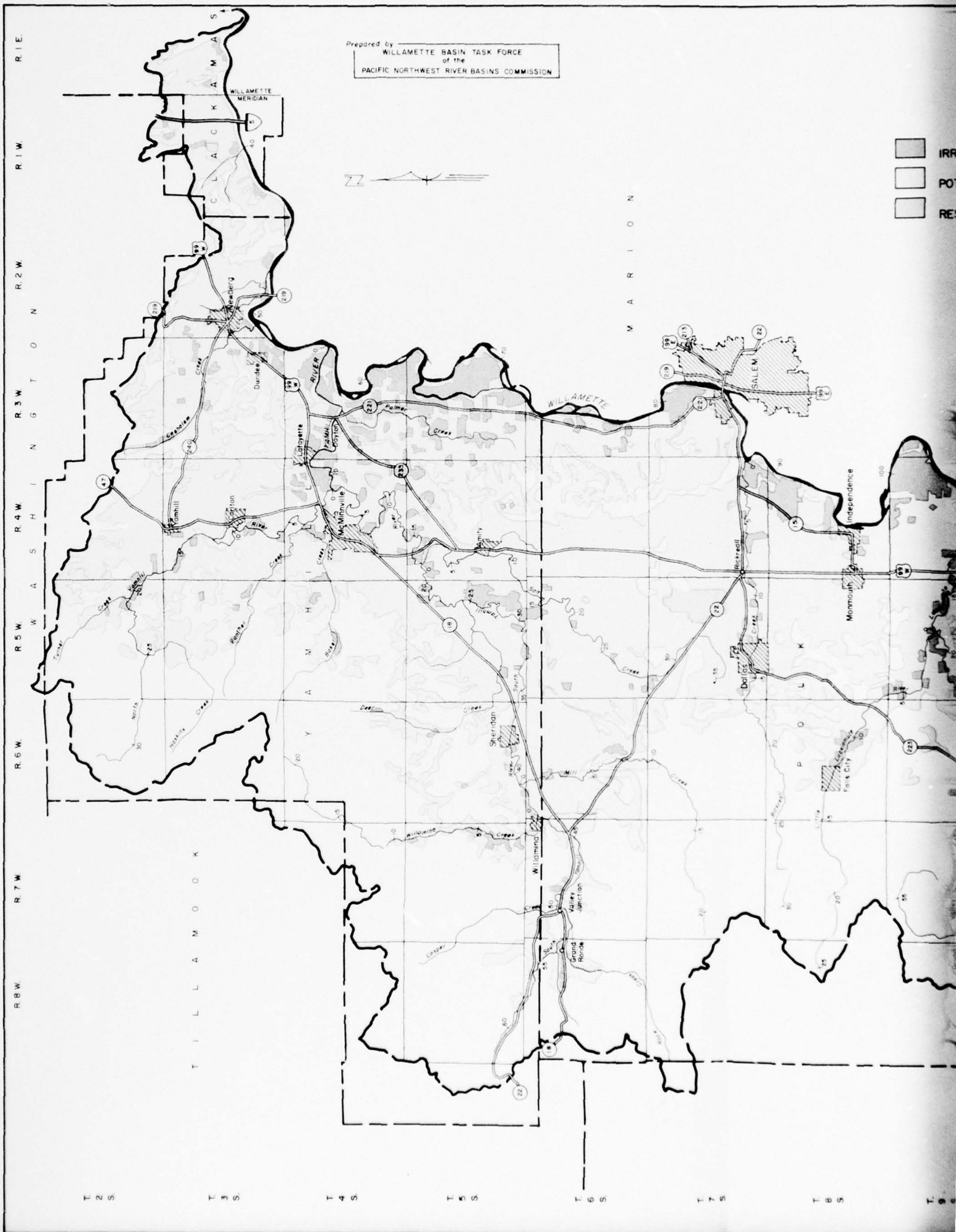
SCALE IN MILES

ED LANDS

IALLY IRRIGABLE LANDS

TIAL-INDUSTRIAL LANDS

WBTF-5-1028d-LL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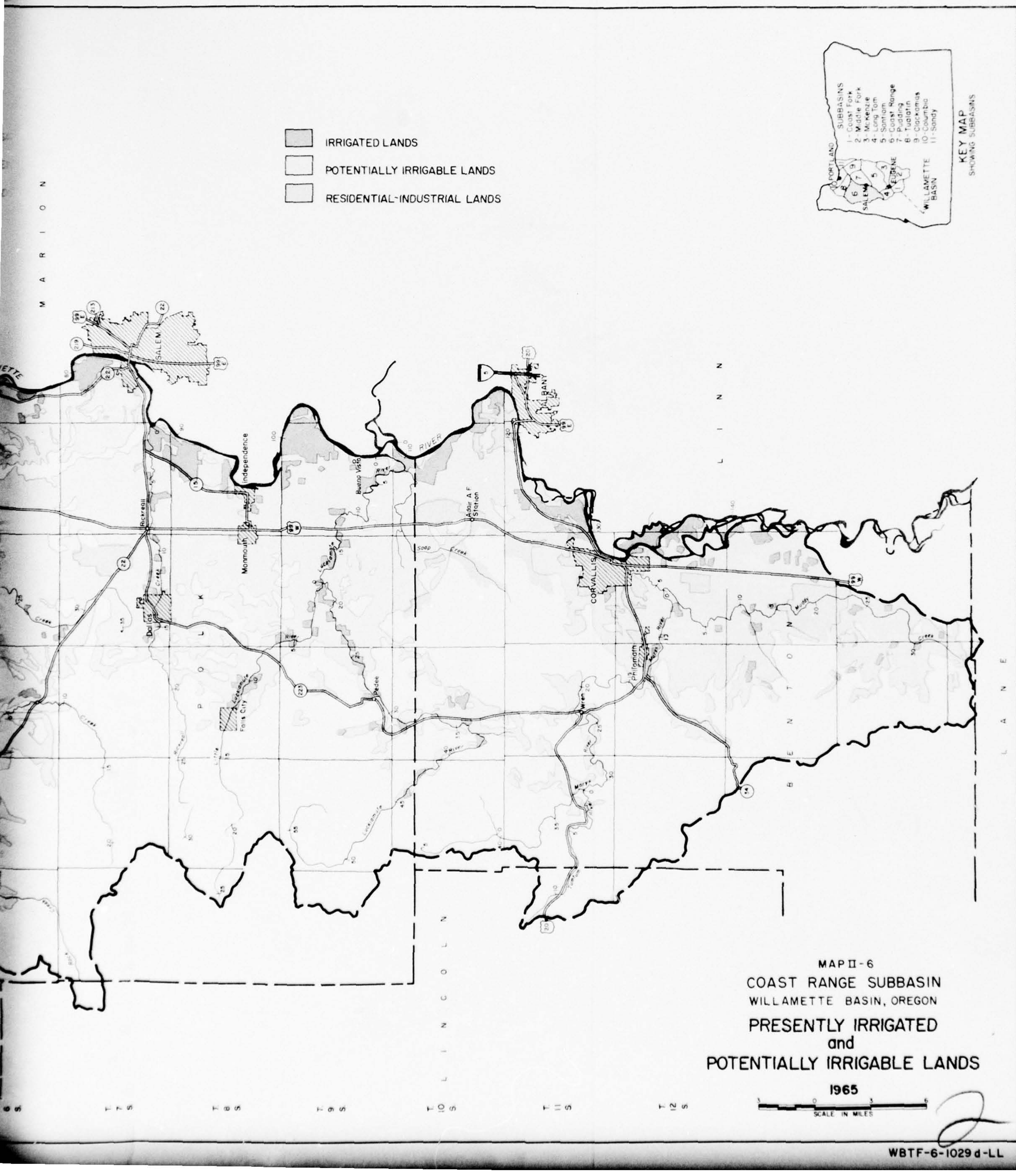
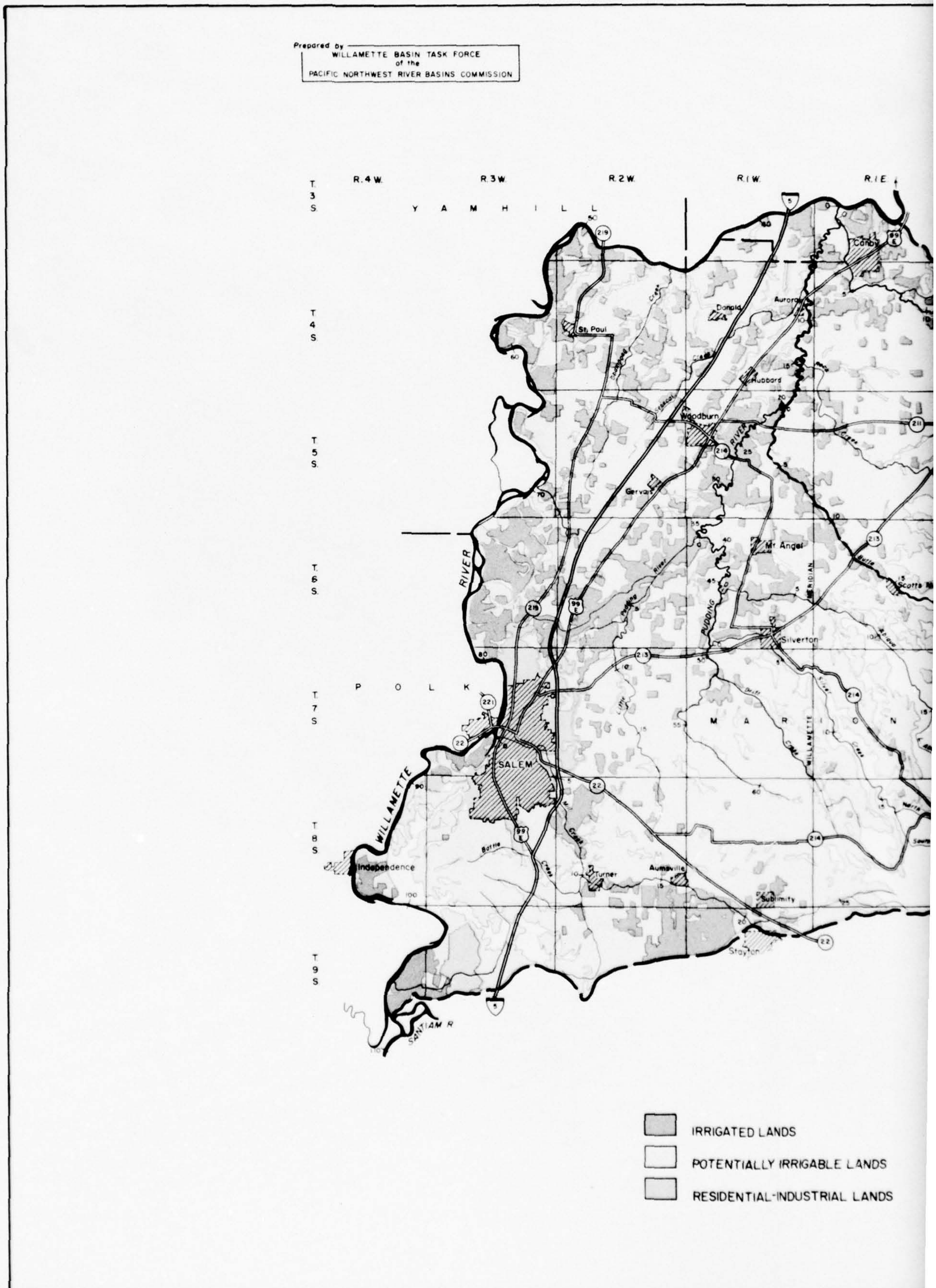
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
WILLAMETTE MERIDIAN
IRRI
POT
RES
CLACKAMAS
MARION
WASHINGTON
YAMHILL
POLK
TILLAMOOK
WILLAMETTE RIVER
Newberg
Dundee
Lafayette
Dayton
McMinnville
Yamhill
Carlton
Amity
Sheridan
Willamina
Valley Junction
Grand Ronde
Dallas
Rickreall
Monmouth
Independence
Falls City
SALEM
R.1E.
R.1W.
R.2W.
R.3W.
R.4W.
R.5W.
R.6W.
R.7W.
R.8W.
T2S
T3S
T4S
T5S
T6S
T7S
T8S



MAP II-6
COAST RANGE SUBBASIN
WILLAMETTE BASIN, OREGON
PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS
1965

WBTF-6-1029d-LL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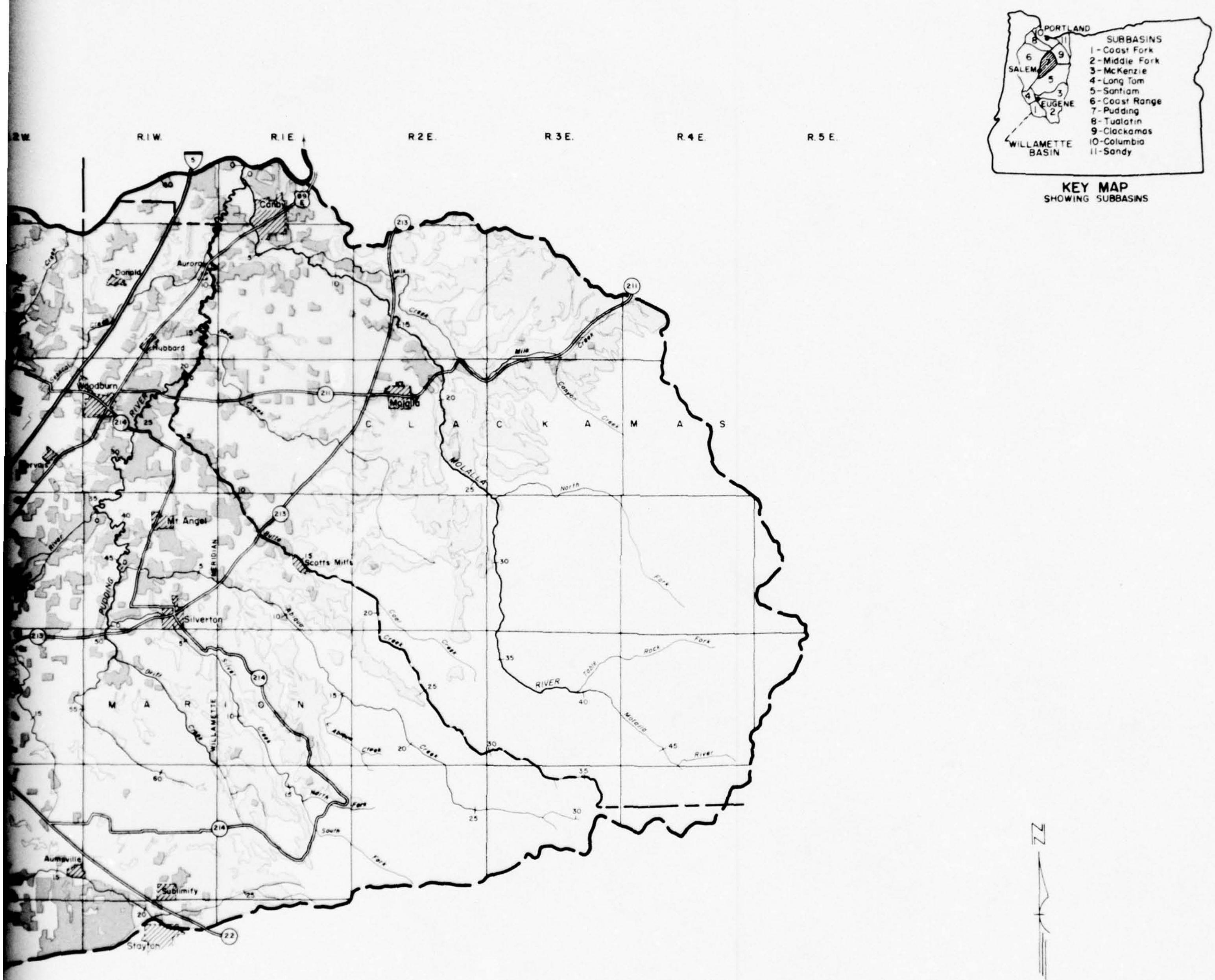
R.4W.
R.3W.
R.2W.
R.1W.
R.1E.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.
T. 7 S.
T. 8 S.
T. 9 S.
YAMHILL
POLK
MARION
WILLAMETTE RIVER
SANTIAM R
PUDDING RIVER
WILLAMETTE MERIDIAN
Canby
Aurora
Donald
St. Paul
Hubbard
Woodburn
Gervais
Mt. Angel
Scotts Mills
Silverton
SALEM
Independence
Turner
Aumsville
Sublimity
Stayton
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



IRRIGATED LANDS

POTENTIALLY IRRIGABLE LANDS

RESIDENTIAL-INDUSTRIAL LANDS

MAP II-7

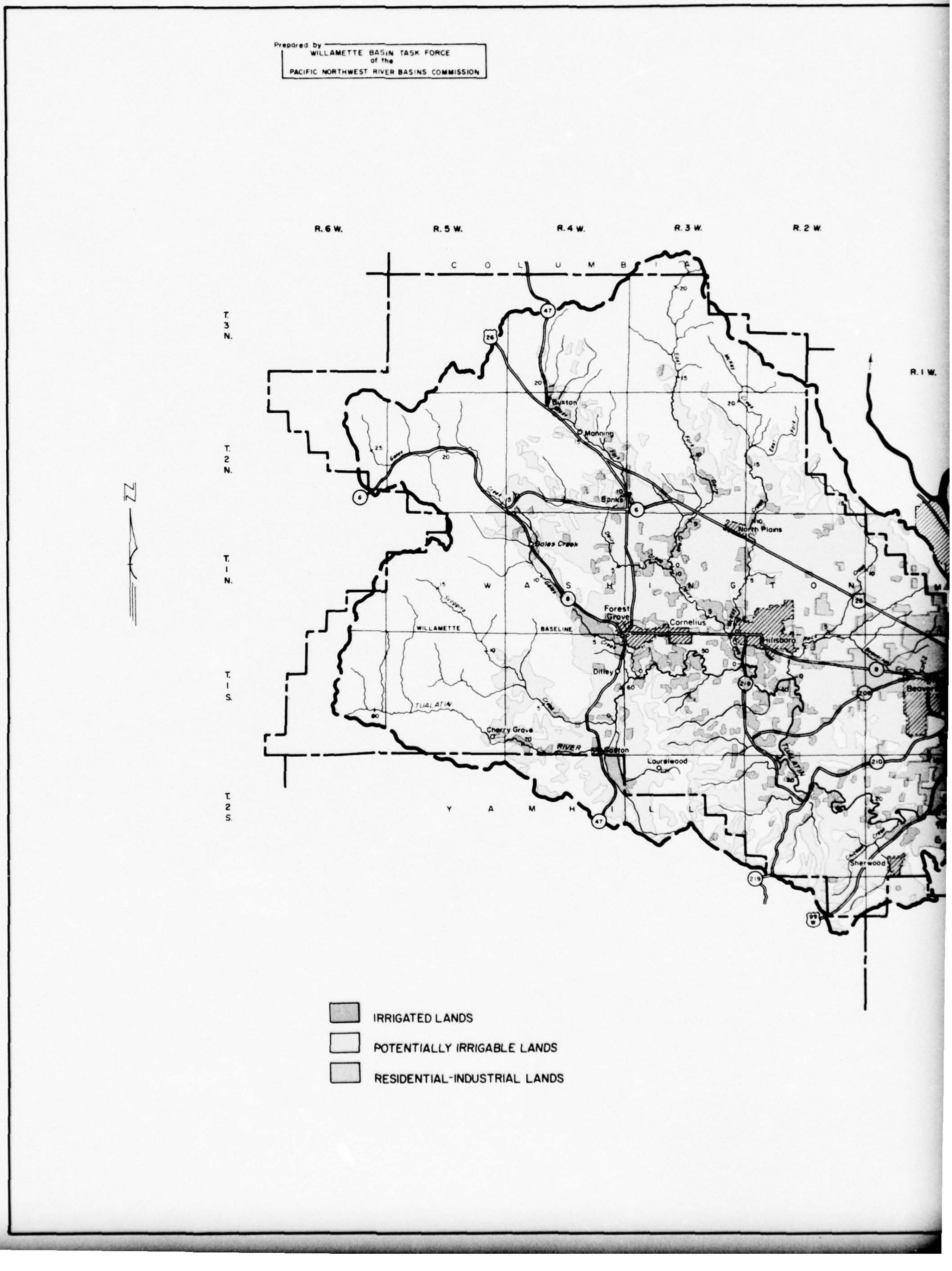
PUDDING SUBBASIN

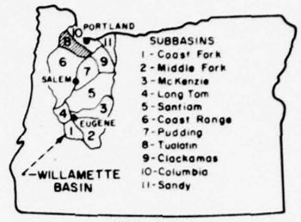
WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED and POTENTIALLY IRRIGABLE LANDS

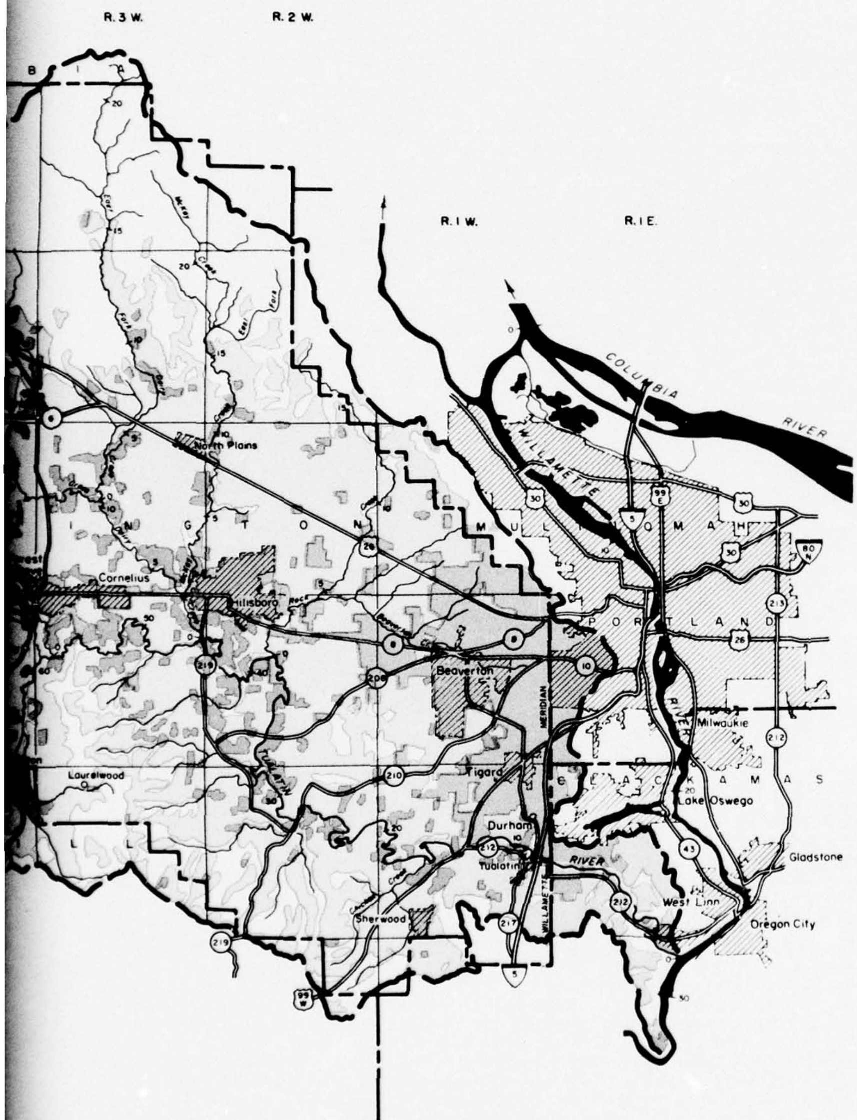
1965

SCALE IN MILES


Prepared by WILLAMETTE BASIN TASK FORCE of the PACIFIC NORTHWEST RIVER BASINS COMMISSION
R. 6 W.
R. 5 W.
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
COLUMBIA
WASHINGTON
YAMHILL
Buxton
Manning
Banks
North Plains
Gales Creek
Forest Grove
Cornelius
Hillsboro
Dilley
Beaverton
Cherry Grove
Gaston
Laurelwood
Sherwood
WILLAMETTE
BASELINE
TUALATIN
RIVER
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



KEY MAP
SHOWING SUBBASINS



MAP II-8

TUALATIN SUBBASIN

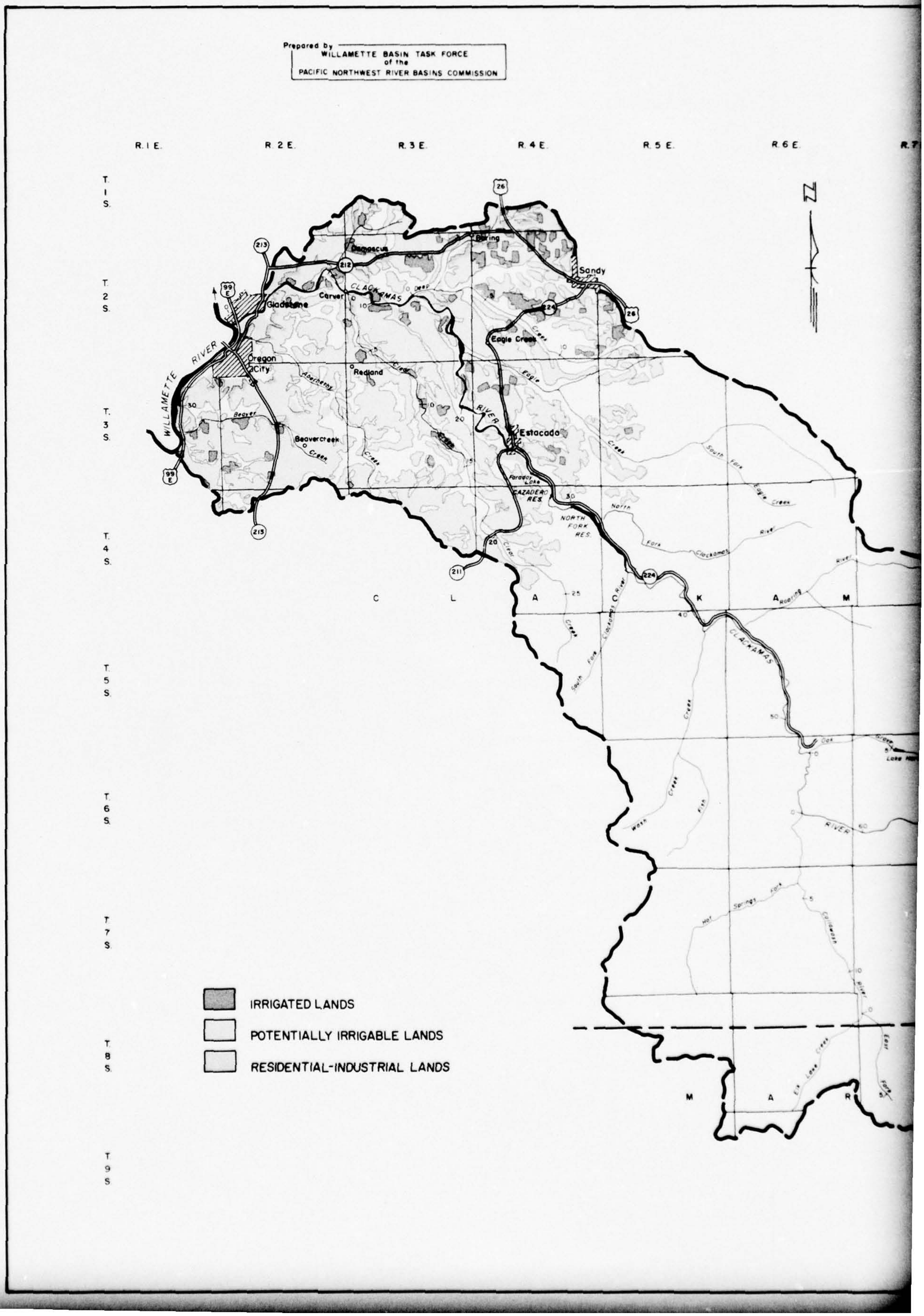
WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

SCALE IN MILES

WBTF-8-1031 d-LL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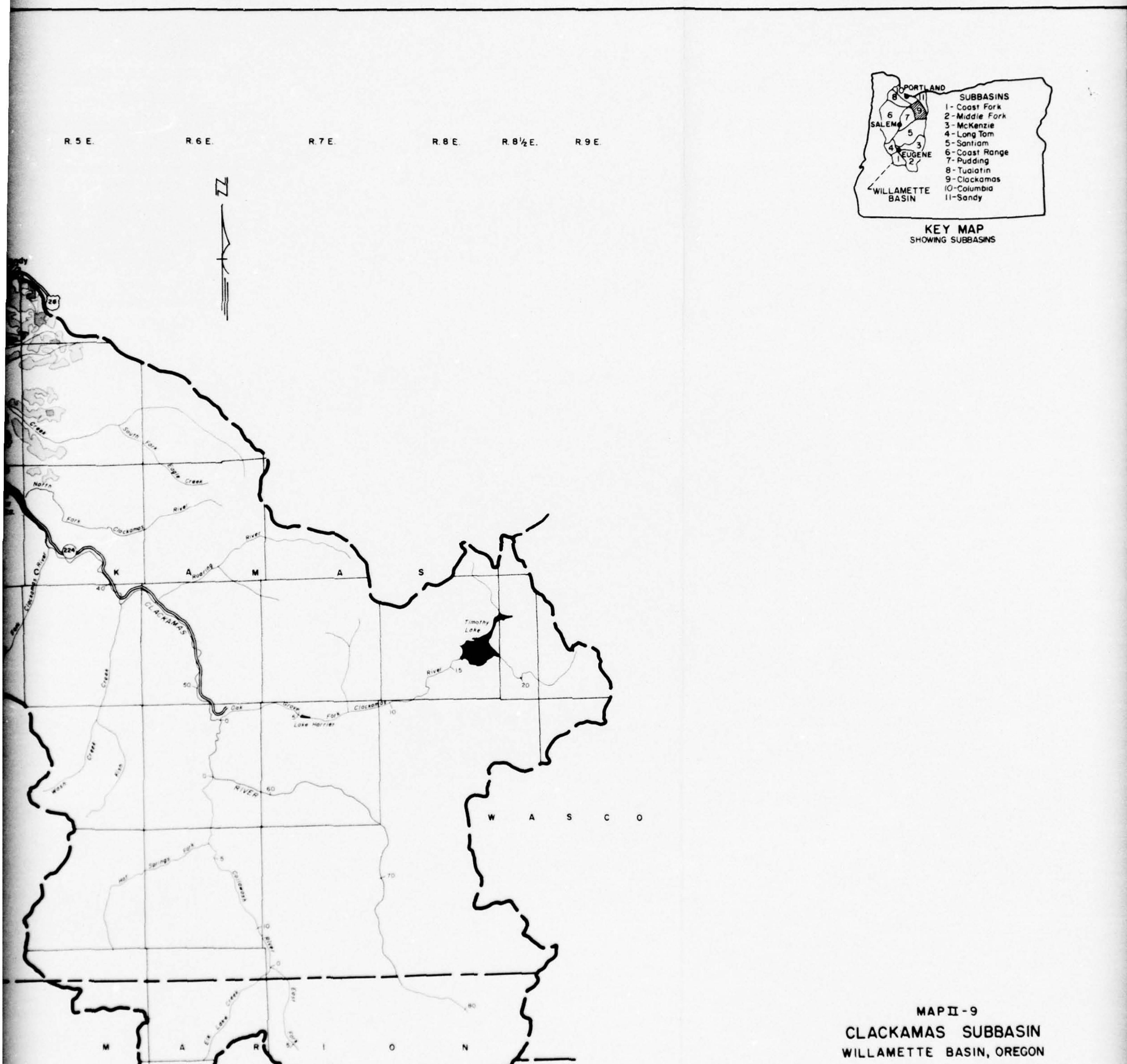
R.1 E.
R.2 E.
R.3 E.
R.4 E.
R.5 E.
R.6 E.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.
T. 7 S.
T. 8 S.
T. 9 S.
Damascus
Boring
Sandy
Gladstone
Carver
Oregon City
Redland
Eagle Creek
Estacada
Beavercreek
WILLAMETTE RIVER
CLACKAMAS RIVER
Faraday Lake
CAZADERO RES.
NORTH FORK RES.
C L A C K A M
M A R
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



MAP II - 9

CLACKAMAS SUBBASIN

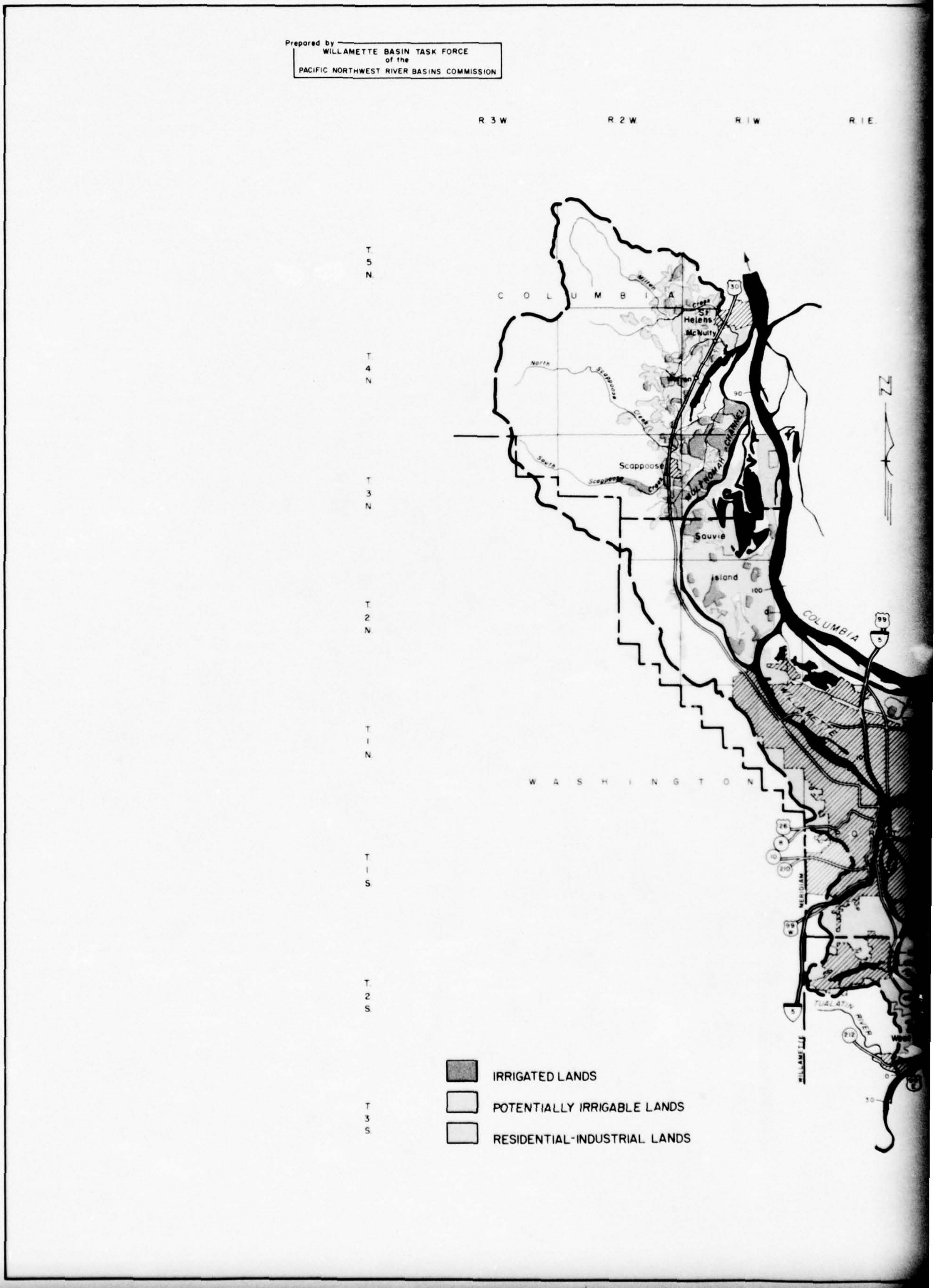
WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

SCALE, IN MILES

WBTF-9-1032d-L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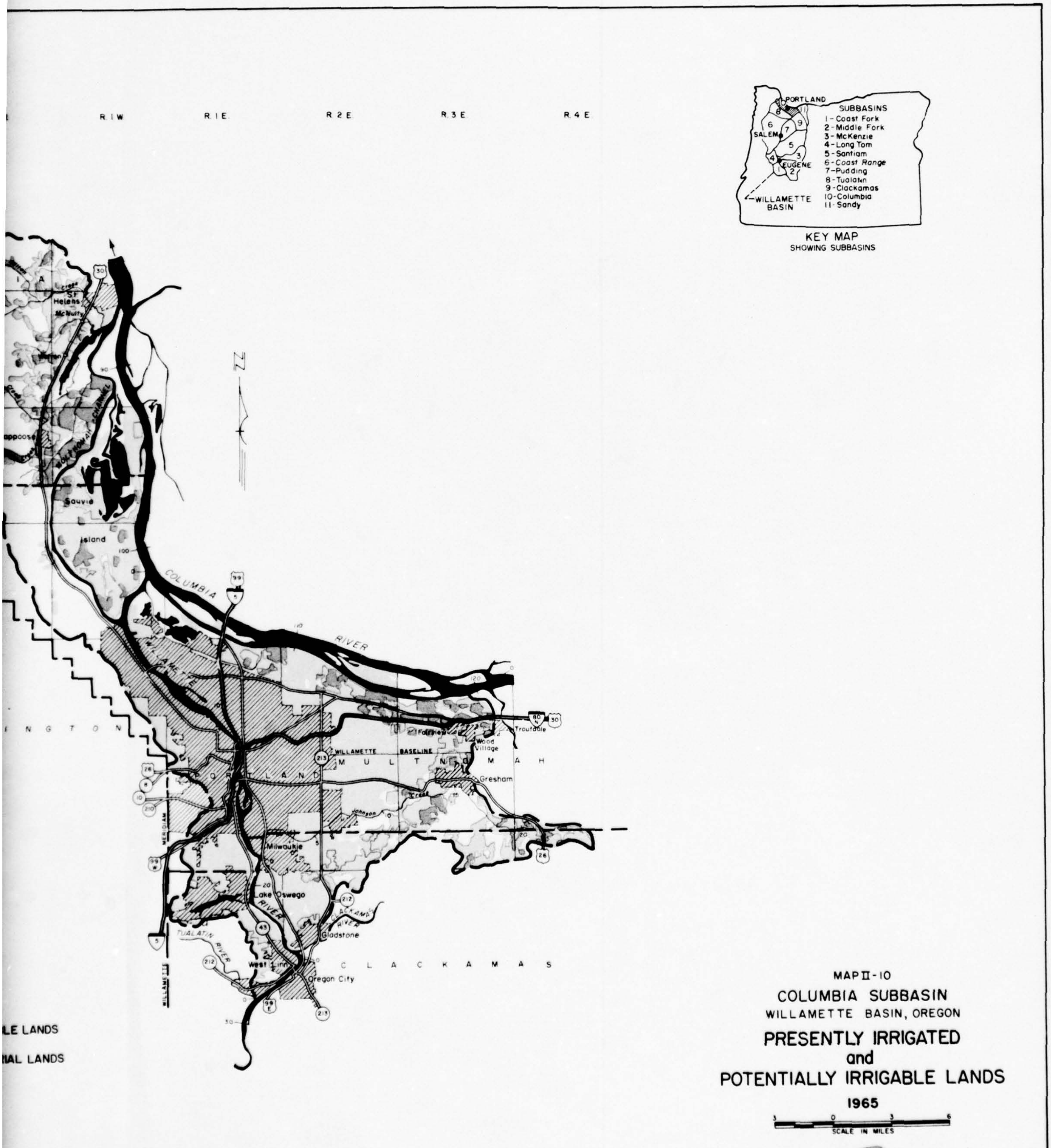
of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
R 3 W
R 2 W
R 1 W
R 1 E
T. 5 N.
T. 4 N
T. 3 N
T. 2 N.
T. 1 N
T. 1 S.
T. 2 S.
T. 3 S.
C O L U M B I A
St Helens
McNulty
North Scappoose Creek
South Scappoose Creek
Scappoose
MULTNOMAH CHANNEL
Souvie
Island
COLUMBIA
W A S H I N G T O N
TUALATIN RIVER
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS



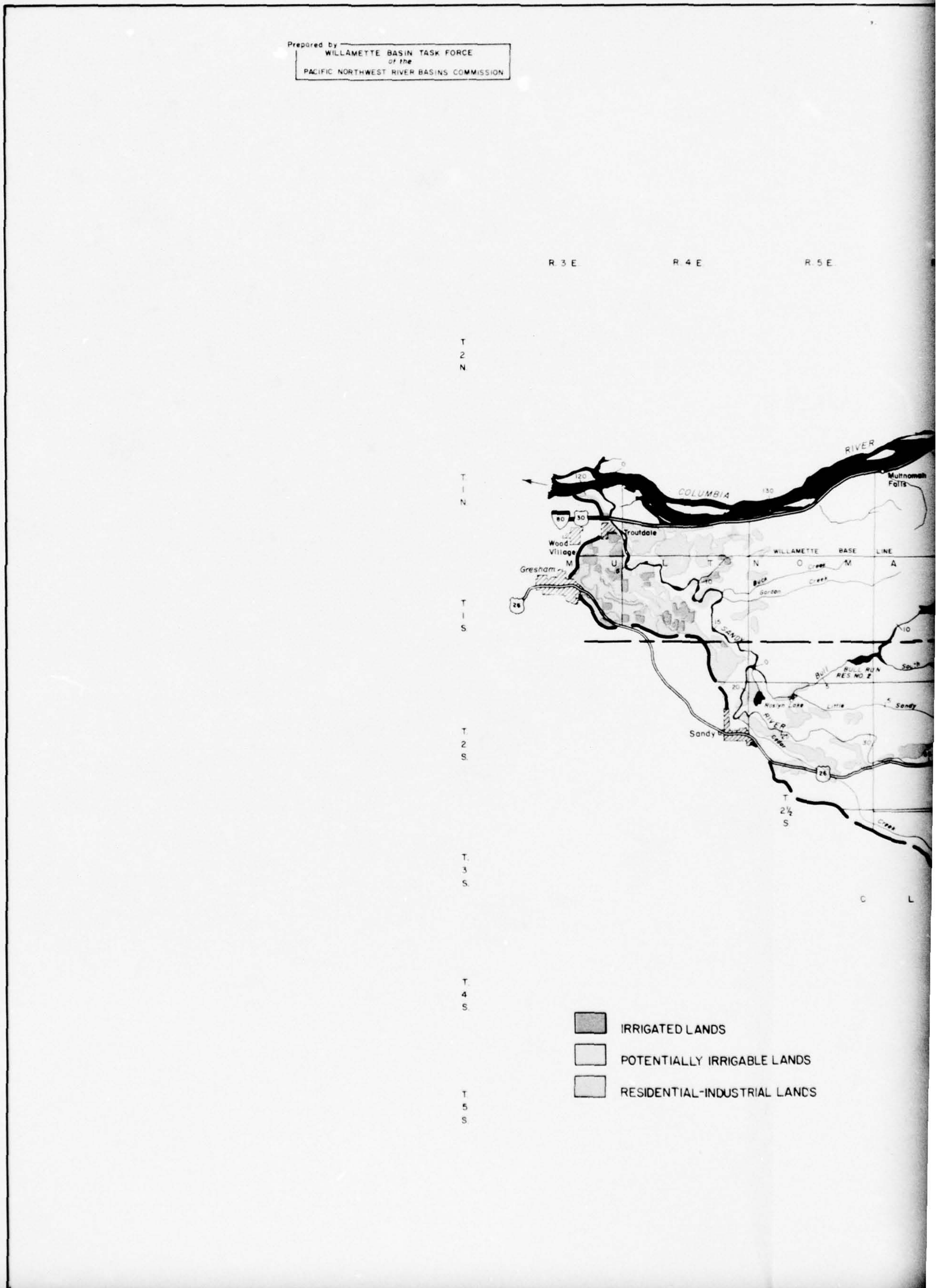
MAP II-10
COLUMBIA SUBBASIN
WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

SCALE IN MILES

WBTF-10-1033d-LL


Prepared by
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of the
PACIFIC NORTHWEST RIVER BASINS COMMISSION
R. 3 E.
R. 4 E.
R. 5 E.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 2½ S
T. 3 S.
T. 4 S.
T. 5 S.
COLUMBIA
RIVER
Multnomah Falls
Troutdale
Wood Village
Gresham
Sandy
WILLAMETTE BASE LINE
BULL RUN RES. NO. 2
Roslyn Lake
Gordon Creek
Little Sandy
IRRIGATED LANDS
POTENTIALLY IRRIGABLE LANDS
RESIDENTIAL-INDUSTRIAL LANDS

GATED LANDS

ENTIALLY IRRIGABLE LANDS

DENTIAL-INDUSTRIAL LANDS

MAP II-11

SANDY SUBBASIN

WILLAMETTE BASIN, OREGON

PRESENTLY IRRIGATED
and
POTENTIALLY IRRIGABLE LANDS

1965

3 0 3 6
SCALE IN MILES

WBTF-11-1034d-LL

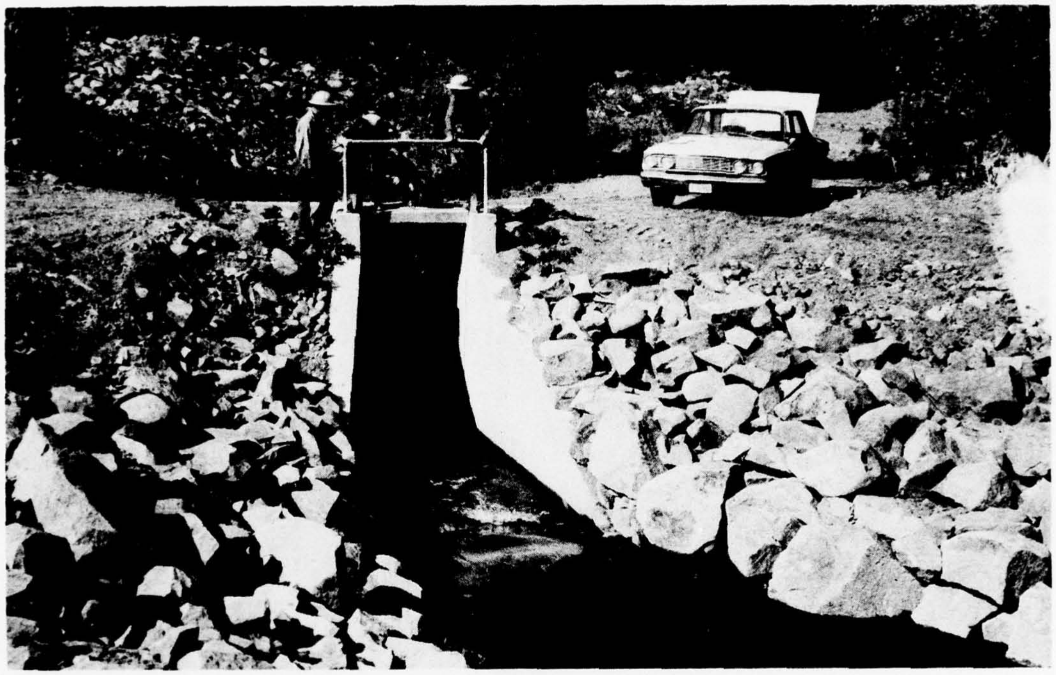


Photo II-1. Surface water being diverted from Crabtree Creek for for Lacomb Irrigation District. (U.S.B.R. Photo)

Although most development to date has been by individuals, almost 10 percent is served by cooperative projects. Oregon State University Special Report 197 of November 1965 (Shearer, M. N., and King, A. S., 1965, Trends and Anticipated Changes in Water-Use Practices for irrigation in the Willamette Valley) shows about 23,000 acres in 14 projects, which are listed in Table II-2; numbers in parentheses refer to first year in operation.

Table II-2
Existing Irrigation Projects, 1964

Project	County	Acres Irrigated
Springfield (1909)	Lane	200
Santiam Water Control Dist. (1909)	Marion	12,000
Molalla Irrigation Co. (1909)	Clackamas	1,158
Foothills Association (1932)	Clackamas	318
Lacomb Irrigation District (1935)	Linn	1,556
Muddy Creeks Irrigation Proj. (1937)	Lane-Linn	2,000
Sidney Ditch (1937)	Marion	2,983
Saint Joe (1938)	Yamhill	150
McLain-Thompson (1948)	Clackamas	10
Calapooya Irrigation Dist. (1950)	Linn	1,000
River View Ditch Association (1953)	Linn	700
Scio Water Improvement Assoc. (1958)	Linn	250
Kingston (1959)	Linn	250
Queener Irrigation Proj. (1960)	Linn	400
Total		22,975

WATER

Irrigation development has occurred in areas where water can be readily obtained with some assurance that an adequate supply will be available throughout the growing season. Ground-water supplies vary throughout the basin; they can be obtained in sufficient quantity for widespread irrigation development in only a few areas. Surface water supplies from most streams cannot satisfy existing water rights during low-flow periods.

Water Sources

Water for 243,660 acres of presently irrigated land in the Willamette Basin is obtained from both surface- and ground-water sources (Table II-3). The relative proportion served from each source is adapted from the U.S. Department of Agriculture Willamette Basin Interim Report, 1964.

Table II-3
Lands Irrigated from Surface-Water and Ground-Water Sources, 1965

Subbasin	Surface Water (acres)	Ground Water (acres)	Total (acres)
1 - Coast Fork	3,230	240	3,470
2 - Middle Fork	1,560	530	2,090
3 - McKenzie	4,640	3,180	7,820
4 - Long Tom	7,010	13,720	20,730
5 - Santiam	27,810	27,000	54,810
6 - Coast Range	27,570	16,400	43,970
7 - Pudding	39,070	33,680	72,750
8 - Tualatin	17,890	1,200	19,090
9 - Clackamas	4,230	2,100	6,330
10- Columbia	8,310	2,450	10,760
11- Sandy	940	900	1,840
Willamette Basin	142,260	101,400	243,660

Surface Water

Most of the surface water in the Willamette Basin originates from precipitation falling on the higher slopes of the Cascade and Coast Ranges. Runoff from precipitation in the form of rain is quite rapid, while runoff from precipitation as snow is sustained over a longer period. Generally, precipitation occurring either in the higher elevations as snow or entering ground-water reservoirs sustains streamflows longer into the irrigation season.

The Coast Range, generally not more than 2500 feet above sea level, consists mainly of sedimentary and igneous rocks of low permeability. Because of moderate snowfall at this low elevation and the scarcity of ground-water storage, the runoff pattern closely follows the precipitation pattern. However, a large percentage of the summer precipitation is lost by evaporation and transpiration, resulting in a lower ratio of summer runoff to summer precipitation. Only about 2 percent of the annual runoff of the Coast Range streams occurs during July, August, and September, the months of highest irrigation requirement.

The lower elevations of the Cascade Range, composed primarily of older, folded, volcanic rocks of low permeability, have runoff characteristics similar to those of the Coast Range. In the higher elevations, soils and younger volcanic formations are porous. In many areas, the younger volcanic formations are largely fragmented and provide ground-water storage of rainfall and snowmelt for gradual releases to springs and streams. Generally, from 5 to 10 percent of the annual runoff of streams originating in the Cascade Range occurs during July, August, and September.

Although there is an abundant annual water supply in the basin, the seasonal distribution of streamflow has restricted irrigation development in many places. Development has occurred where supplies can be easily obtained. The U.S. Department of Agriculture Interim Report of 1964 indicates that about 10 percent of the lands irrigated from streams receive supplemental supplies from storage.

Photo II-2. This small sprinkler system located near Sublimity is typical of many that exist along the smaller perennial streams of the valley.
(U.S. Department of Agriculture Photo)

Ground Water

The availability of ground water in sufficient quantity for irrigation varies considerably throughout the agricultural area of the Willamette Valley. Supplies are generally available in the areas adjacent to Willamette River and the major Cascade Range tributaries. These areas are composed largely of permeable, relatively silt-free, younger alluvium originating from the volcanic rocks of the Cascade Range. The younger alluvium found along the Coast Range tributaries and tributaries originating in the lower elevations of the Cascade Range is generally composed of poorly-sorted sand and gravel with much silt; hence permeability and water yields are highly variable.

The main valley floor is composed of older alluvium interspersed with permeable zones of sand and gravel. The older alluvium generally contains much silt which reduces permeability. The permeable zones within the older alluvium may furnish adequate supplies of ground water, depending on size and thickness of the zones and interconnections with other permeable zones. Sedimentary rocks extending under the valley from the Coast Range foothills and older volcanic rocks in the foothills of the Cascade Range do not generally yield adequate supplies for irrigation. Maps showing the availability of ground water within the basin are contained in the Hydrology Appendix.

Quality of Water

Surface waters in the basin are of excellent quality for irrigation, and ground-water quality is suitable in most places. Ground waters, because of their longer contact with soils and rocks, have larger concentrations of dissolved solids. The only ground water unsuitable for irrigation comes from a few mineral springs or from deep wells mostly in bedrock; in most of these cases, the yields are insufficient for irrigation.

The quality of ground water from individual wells is fairly constant throughout the year while the quality of surface water varies with the amount of flow. Surface waters, at low flows, include a higher percentage of ground-water inflow and total dissolved solids than at high flows. Analyses of typical surface- and ground-water samples are shown in Table II-4.

Irrigation Water Rights

The increasing demand for a uniform and orderly way of initiating, recording, and perfecting water rights resulted in the enactment of the Oregon Water Laws on February 24, 1909. These laws provide that "...all water within the State from all sources of water supply belongs to the public." Nothing in the laws can be so construed as to take away or impair the vested right of any person to surface waters, the use of which was initiated prior to February 24, 1909.

Table II-4

Representative Chemical Analyses of Irrigation Water 1/

Location of Sample				pH	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron B	Dissolved Solids	Sodium adsorption ratio	Specific conductance (micromhos at 25° C)
					Parts per Million													
Surface water 2/																		
Middle Fork Willamette River at Jasper					18	5.0	1.3	2.5	0.9	28	1.4	1.0	0.1	0.3		45	0.26	51
Coast Fork Willamette River near Cottage Grove					14	6.0	1.7	3.1	0.4	32	0.6	1.2	0.0	0.2		43	0.28	59
McKenzie River near Coburg					23	5.0	1.9	4.4	1.2	35	2.3	1.8	0.2	0.1		55	0.42	64
Willamette River at Harrisburg					18	5.0	1.6	3.6	0.8	31	1.0	1.5	0.1	0.0		54	0.36	56
North Santiam River at Mehama					16	4.0	0.7	2.1	0.6	22	1.2	0.5	0.1	0.0		32	0.25	38
Santiam River at Jefferson					14	4.0	2.3	2.5	0.5	23	3.2	0.5	0.0	0.2		38	0.25	48
South Yamhill River near Whiteson					15	12	3.8	8.4	0.7	57	4.2	9.2	0.1	0.0		82	0.54	130
Clackamas River near Estacada					19	6.5	1.6	4.3	1.0	36	1.2	2.5	0.1	0.2		54	0.40	71
Ground water																		
County	Township	Range	Section															
Lane	19S	3W	15	7.0	54	18	2.2	12	0.2	90	3.4	4.0	0.1	0.4		139	0.70	156
Linn	12S	2W	11	8.2	38	9.6	1.9	27	1.0	96	4.1	6.0	0.0	0.0		139	2.1	169
Benton	14S	5W	28	7.5	50	14	3.2	11	1.5	75	10	3.0	0.3	0.2		126	0.70	145
Marion	5S	2W	26	7.7	47	25	17	15	2.2	192	1.7	11	0.1	2.0	0.14	203	0.56	308
Clackamas	2S	3E	5	7.7	60	9.5	6.4	7.0	0.7	70	0.6	4.0	0.1	3.5	0.2	126	0.42	124
Washington	1N	3W	1	7.6	49	15	7.9	31	9.0	136	2.1	23	0.2	0.1	0.3	204	1.6	283

1/ *Sampling and analysis by U.S. Geological Survey*

2/ *Surface water samples were obtained during low flow months in 1959 and 1960.*

Prior to enactment of the water code, water could be appropriated for beneficial use by any riparian proprietor. This appropriation created a vested right to the extent of the actual application of water to beneficial use, provided the use was not abandoned for a continuous period of two years. Under the doctrine of appropriation, "the first in time is the first in right," to the extent of the quantity of water which has been applied to beneficial use. A claim to a vested right, by virtue of use prior to February 24, 1909, and continued use thereafter, can be determined and made a matter of record only through a legal proceeding known as adjudication. This proceeding involves several administrative steps by the State Engineer and is concluded by a decree of the court. Without these proceedings, the value of most rights, both early and late, remains in doubt.

Only nine streams in the Willamette Basin have been adjudicated (Table II-5). Two others, Rickreall Creek and Luckiamute River, are in the initial stages of adjudication proceedings. The rest of the basin should also be adjudicated as a first step to obtain the maximum beneficial use of its waters.

Table II-5
Adjudicated Streams and Associated Irrigation Water Rights

Subbasin	Stream	County	Vested Rights (acres)
5 - Santiam	Calapooia River	Linn	90
5 - Santiam	North Santiam River	Marion & Linn	2,031
6 - Coast Range	Mill Creek	Yamhill	14
7 - Pudding	Bachert & Netter Creeks 1/	Clackamas	none
7 - Pudding	Mill Creek	Marion	74
7 - Pudding	Unnamed tributary Willamette River	Marion	4
8 - Tualatin	Tualatin River	Washington & others	457
8 - Tualatin	Unnamed tributary Tualatin River	Washington	7
Total			2,677

1/ *Rights allowed for stock and domestic use only*

The State Engineer issues permits and certificates for water rights initiated after enactment of the water code. As of July 1965, according to the State Water Resources Board, there were 374,771 acres of land in the basin with surface water rights (both adjudicated and with permits) for the diversion of 4,554 cubic feet per second (c.f.s.) as shown in Table II-6; water rights on main stem Willamette River are included in the appurtenant subbasin total.

Table II-6
Irrigation Surface-Water Rights

Subbasin	Diversion Rights (cfs)	Appurtenant Lands (acres)
1 - Coast Fork	85	6,800
2 - Middle Fork	31	2,441
3 - McKenzie	1,494	119,817
4 - Long Tom	135	10,880
5 - Santiam	1,050	80,545
6 - Coast Range	590	50,684
7 - Pudding	512	43,493
8 - Tualatin	351	30,610
9 - Clackamas	60	5,593
10 - Columbia	236	23,085
11 - Sandy	10	823
Willamette Basin	4,554	374,771

Under Oregon law, a water right developed and perfected is valid and is subject to loss only by abandonment. If the owner of a perfected certified right ceases to use water for 5 successive years, the right to use shall cease; failure to use shall be conclusively presumed to be an abandonment of the water right. To have a water right declared abandoned under the law before August 1955, it was necessary to initiate a proceeding in the circuit court. Laws effective in August 1955, permit the State Engineer to accept voluntary authorization of abandonment by the owner of a water right. However, according to the State Engineer, thousands of water rights in Oregon have been abandoned for failure to use the water for a period of 5 years, although they remain on record as a valid water right. Unused and uncancelled water rights preclude an accurate quantitative appraisal of the available water resources and the value of all water rights. Under the provisions of the August 1955 law, about 58 rights for the irrigation of 1,710 acres in the Willamette Basin had been canceled as of June 1964.

Permits for irrigation from ground-water sources must be obtained whenever the area to be irrigated exceeds one-half acre. However, most of the ground-water irrigation use in the basin was established before the 1955 Ground-Water Act was passed and was registered with the State Engineer, as required by the act. As of July 1965, irrigation ground-water rights totaled 2,054 cubic feet per second for 138,468 acres (Table II-7).

Table II-7
Irrigation Ground-Water Rights

Subbasin	Registrations Before 1955 (cfs) 1/	Registrations Before 1955 (Acres)	Permits After 1955 (cfs)	Permits After 1955 (Acres)
1 - Coast Fork	9	648	2	185
2 - Middle Fork	14	742	5	386
3 - McKenzie	71	2,869	6	467
4 - Long Tom	326	13,758	35	3,034
5 - Santiam	440	22,239	56	4,918
6 - Coast Range	289	18,553	61	5,624
7 - Pudding	404	32,642	201	19,090
8 - Tualatin	36	4,097	14	1,372
9 - Clackamas	13	1,468	8	719
10 - Columbia	45	4,177	11	544
11 - Sandy	5	497	3	439
Willamette Basin	1,652	101,690	402	36,778

1/ *cfs for registered wells could indicate the capacity of well or pump rather than beneficial use per acre.*

Storage rights for irrigation totaled 845,161 acre-feet as of July 1965. Of this total, rights for 835,000 acre-feet cover conservation storage for multipurpose use in five Federal reservoirs (Cottage Grove, Dorena, Fern Ridge, Lookout Point, and Detroit). The remaining 10,161 acre-feet of rights are for storage in many small reservoirs scattered throughout the basin. Storage rights are summarized in Table II-8.

Table II-8
Irrigation Storage Rights, 1965

Subbasin	Federal Storage (acre-feet)	Other Storage (acre-feet)	Total (acre-feet)
1 - Coast Fork	100,000	11	100,011
2 - Middle Fork	340,000	32	340,032
3 - McKenzie		685	685
4 - Long Tom	95,000	556	95,556
5 - Santiam	300,000	252	300,252
6 - Coast Range		4,878	4,878
7 - Pudding		1,721	1,721
8 - Tualatin		1,438	1,438
9 - Clackamas		374	374
10 - Columbia		114	114
11 - Sandy		100	100
Willamette Basin	835,000	10,161	845,161

The irrigation storage rights in the Federal reservoirs are held by the Bureau of Reclamation. As of January 1966, 31 water service contracts had been executed with water users for 5,780 acre-feet to irrigate 2,690 acres.

Water Requriements

Average monthly water requirements for sprinkler irrigation provide the basis for determining present use of water on irrigated lands. They are conservatively high for use in planning future developments and consequently may be higher than actual use on many specialty and row crops grown in the basin. Irrigation requirements, estimated from climatological records at Forest Grove, Salem, Albany, and Eugene, are considered to be representative of the agricultural area. Crop consumptive use and irrigation requirements are based on factors of temperature, precipitation, estimated cropping practices, and depth and moisture characteristics of soils.

Agricultural census data for 1959 indicate Willamette Basin irrigated cropping is about 52 percent forage crops, 29 percent specialty crops, 10 percent feed grains, and 9 percent miscellaneous. Water requirements are estimated for pasture, small grain, sweet corn, and beans to represent the several groups of crops grown in the basin.

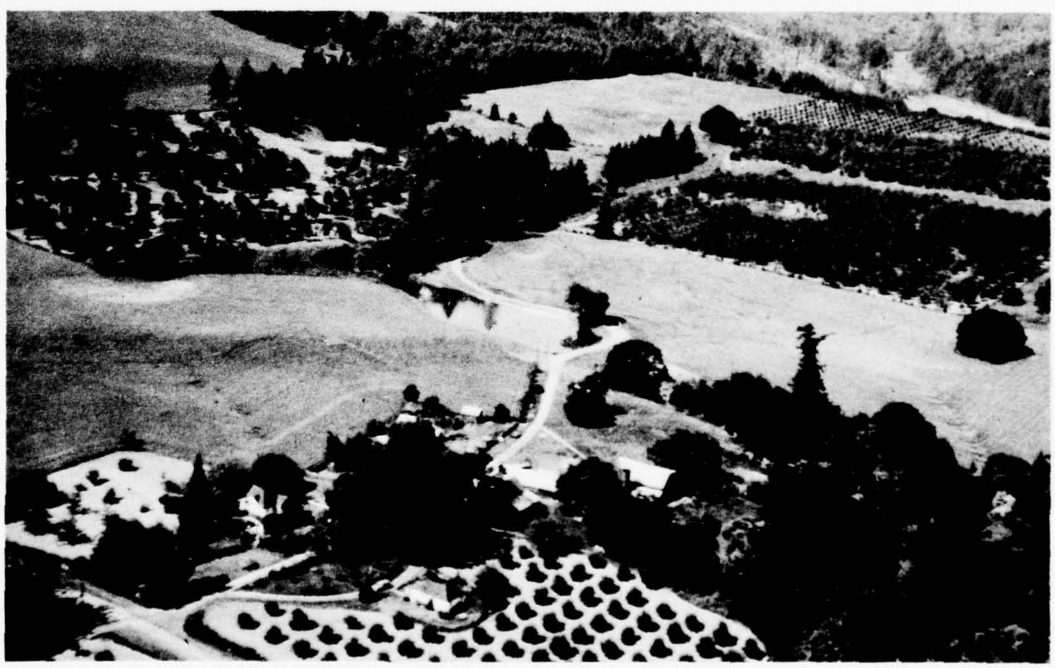


Photo II-3. This irrigation reservoir northwest of Salem is typical of small storage developments found throughout the basin.
(U.S. Department of Agriculture Photo)

Crop Consumptive Use

Consumptive use (evapotranspiration) is the amount of water used by plants in transpiration and building of plant tissue plus that evaporated from adjacent soil and plant foliage. The average crop consumptive-use requirements are presented in Table II-9 for the four climatological stations.

Table II-9
Average Crop Consumptive-Use Requirements in Inches

Location	Pasture	Corn	Beans	Grain
Forest Grove	30.1	19.6	13.3	15.5
Salem	30.4	19.5	13.4	15.2
Albany	31.0	19.6	13.4	15.2
Eugene	30.0	19.2	13.1	14.8

Crop Irrigation Requirement

The crop irrigation requirement is the amount of irrigation water needed to meet consumptive use not met by effective seasonal precipitation. The amount of water and the number of irrigations required during a season vary from year to year depending on consumptive use, effective precipitation, and the allowable soil moisture use in the crop root zone during the irrigation season. Average seasonal crop irrigation requirements (irrigation consumptive use) are shown in Table II-10.

Table II-10
Average Crop Irrigation Requirements in Inches

Location	Pasture	Corn	Beans	Grain
Forest Grove	19.7	15.7	11.1	10.6
Salem	19.9	15.7	11.3	10.3
Albany	20.0	15.7	11.2	10.0
Eugene	19.2	15.2	11.1	9.7

Since irrigation requirements are nearly the same throughout the Willamette Basin for a particular crop, average requirements at Salem are considered representative of the entire basin.

Farm Delivery Requirement

The farm delivery requirement is the amount of water required at the farm headgate to meet the crop irrigation needs and allow for farm losses. The farm loss is the difference between the farm delivery requirement and the irrigation requirement and generally ranges from 30 to 60 percent. Losses with sprinkler irrigation include evaporation, surface runoff, deep percolation and farm distribution system losses. Thus, farm irrigation efficiencies range from about 40 to 70 percent depending to a large extent on the irrigation practices of the individual farmer. In this study irrigation efficiencies are estimated to average 60 percent. Farm delivery requirements for representative crops in the Willamette Basin are shown in Table II-11.

Table II-11
Farm delivery Requirements by Crop In Inches

Month	Pasture	Corn	Beans	Grain
May	2.4	1.2	-	6.0
June	8.4	6.0	4.8	7.2
July	9.6	10.8	8.4	3.6
August	8.4	8.4	6.0	-
September	4.8	-	-	-
Total	33.6	26.4	19.2	16.8
Total in Feet	(2.8)	(2.2)	(1.6)	(1.4)

Average farm delivery requirements for presently irrigated land, shown in Table II-12, are estimated from the above crop requirements and 1959 cropping pattern.

Water Utilization

More than one-half million acre-feet of surface water and ground water are used annually for irrigation in the basin, but this is only a small part of the total available annual water supply. Lands along the Willamette River and major tributaries generally have an adequate water supply; however, shortages occur to the lands served from tributary streams that are without storage facilities.

Table II-12
Average Farm Delivery Requirements in Inches

Month	Upper Subarea	Middle Subarea	Lower Subarea
May	2.4	2.4	2.4
June	7.2	7.2	7.2
July	8.4	8.4	9.6
August	7.2	6.0	7.2
September	2.4	2.4	3.6
Total	27.6	26.4	30.0
Total in Feet	(2.3)	(2.2)	(2.5)

Surface Water

Over 142,000 acres in the basin were irrigated from surface-water sources in 1965. Based on estimated requirements, these lands require an average annual diversion or pumpage from streams, reservoirs, and ponds of about 345,000 acre-feet. The actual use is only 330,000 acre-feet because of water shortages totaling 15,000 acre-feet. These diversions deplete streamflow by about 215,000 acre-feet; return flows to streams and ground-water reservoirs amount to an estimated 115,000 acre-feet annually, or about 33 percent of the diversions. Irrigation from surface-water sources is summarized by subbasin in Table II-13.

About 95 percent of all irrigated lands in the basin are irrigated by sprinkler methods through closed-pipe systems. There is little loss in pumping from surface-water sources directly into farm sprinkler systems. In areas where most of the lands are served in this manner, distribution system losses are estimated to average about 5 percent. In the Santiam and McKenzie Subbasins a significant portion of the lands are served from unlined canal and lateral distribution systems, and therefore, the distribution system seepage losses and operational waste are estimated to average about 10 percent.

In the basin, farm losses, distribution system losses, and waste total an estimated 151,000 acre-feet annually. Of this amount, about 36,000 acre-feet (24 percent) are lost to nonbeneficial consumptive use, and the remaining 115,000 acre-feet return to stream channels and ground-water reservoirs.

Surface-water supplies for presently irrigated lands along the Willamette River and most major tributaries are generally adequate. However, supplies are inadequate on many tributary streams without storage. Water supplies available to individual farms located on smaller tributary streams vary considerably because of prior water rights and seasonal distribution of runoff. It is estimated that about 10 percent of the irrigated lands in Willamette Basin do not receive an adequate water supply. These lands receive a supply equivalent to about 75 percent of their requirement. The estimated shortages for presently irrigated lands in each subbasin are shown in Table II-13. These shortages are for lands actually being irrigated; however, only about 38 percent of lands with surface-water rights are irrigated in any one year. The shortage in many areas would be greater if all lands with water rights were being irrigated.

Table II-13
Irrigation from Surface-Water Sources, 1965

Subbasin	Irrigated Land (Acres)	Diversion Requirement (Acre-feet)	Average Diversions (Acre-feet)	Average Shortage (Acre-feet)	Return Flow (Acre-feet)	Depletions (Acre-feet)
1-Coast Fork	3,230	7,800	7,600	200	2,600	5,000
2-Middle Fork	1,560	3,800	3,800	0	1,300	2,500
3-McKenzie	4,640	11,800	11,700	100	4,300	7,400
4-Long Tom	7,010	16,900	16,700	200	5,700	11,000
5-Santiam	27,810	68,000	67,500	500	24,800	42,700
6-Coast Range	27,570	63,800	62,700	1,100	21,500	41,200
7-Pudding	39,070	90,400	87,600	2,800	30,100	57,500
8-Tualatin	17,890	47,000	38,400	8,600	13,100	25,300
9-Clackamas	4,230	11,100	10,200	900	3,500	6,700
10-Columbia	8,310	21,900	21,300	600	7,300	14,000
11-Sandy	940	2,500	2,500	0	800	1,700
Willamette Basin	142,260	345,000	330,000	15,000	115,000	215,000

Ground Water

Of the 138,468 acres covered by ground-water registrations and permits, about 101,400 acres, or 73 percent, were irrigated in 1965. Based on estimated requirements, and assuming distribution system losses and waste of 5 percent, about 239,000 acre-feet are being pumped annually from ground-water reservoirs of the basin. Since a portion of this returns to ground water, irrigation depletes ground-water reservoirs by an estimated 157,000 acre-feet annually, as shown in Table II-14.

Table II-14
Irrigation from Ground-Water Sources, 1965

Subbasin	Irrigated Land (Acres)	Average Pumpage (Acre-feet)	Return to Ground Water (Acre-feet)	Depletions (Acre-feet)
1 - Coast Fork	240	600	200	400
2 - Middle Fork	530	1,300	400	900
3 - McKenzie	3,180	7,700	2,600	5,100
4 - Long Tom	13,720	33,200	11,400	21,800
5 - Santiam	27,000	62,600	21,500	41,100
6 - Coast Range	16,400	38,000	13,100	24,900
7 - Pudding	33,680	78,000	26,800	51,200
8 - Tualatin	1,200	3,200	1,100	2,100
9 - Clackamas	2,100	5,500	1,900	3,600
10 - Columbia	2,450	6,500	2,200	4,300
11 - Sandy	900	2,400	800	1,600
Willamette Basin	101,400	239,000	82,000	157,000

Note: Data on shortages not available

Photo II-4. Irrigation such as shown on this field of strawberries near Jefferson has played a vital role in making the Willamette Valley a national leader in fruit and vegetable production.
(U.S. Bureau of Reclamation Photo)

IRRIGATION ECONOMY

Since 1950, the Willamette Basin has followed the national trend in which total agricultural output has increased by about 35 percent, while cropland has declined slightly. Mechanization and technological improvements, plus a 2-1/2-fold increase in irrigated acreage in the basin, have contributed greatly to this production increase. The growth in irrigation has permitted a noteworthy change in farming techniques, producing attractive profits in the basin during this period. Irrigated farming has combined a high degree of mechanization with the use of fertilizers, because irrigation makes it profitable to use greater amounts of fertilizer than would be otherwise possible.

Irrigation plays a major role in the agricultural economy of the Willamette Basin. Although constituting less than one-tenth of all land in farms, the irrigated lands produce more than one-third of the value of all agricultural production. Oregon leads the Nation in the production of snap beans and processed strawberries, and is a major producer of sweet corn, mint, hops, and a variety of nursery crops. Virtually all this production occurs on the irrigated land in the Willamette Basin. The processing of these crops and a variety of other fruits, vegetables, and nuts has made Marion County one of the leading food-processing centers in the United States. Moreover, a substantial livestock industry is supported in part by large acreages of irrigated pasture, forages, and feed grains.

Photo II-5. Irrigated onions on Lake Labish. Irrigation makes only a minor demand on the basin's total water resources, but constitutes a substantial part of the agricultural economy.
(U.S. Bureau of Reclamation Photo)

The economic and social impact of irrigation is reflected in many ways, ranging from direct employment and income to a general stabilizing effect on the basin economy.

The 1964 Census of Agriculture is the basis for the following discussion of the basin's "present" irrigation economy. These data are the most recently available and, unless noted, are used. The census is the most comprehensive source of agricultural economic data available. Moreover, it is available for regular intervals over many years, permitting thorough analysis of historical trends. Census data are enumerated by counties, and county boundaries closely approximate the periphery of the basin. The economic study areas for the Upper, Middle, and Lower Subareas include the following nine counties: Upper - Lane; Middle - Benton, Linn, Marion, Polk, and Yamhill; and Lower - Clackamas, Multnomah, and Washington.

Farm Types and Land Use

In 1964, there were approximately 2.4 million acres, representing about 29 percent of the total land area in the basin, included in 20,400 farms. Nearly one farm in four, or 4,860 farms, reported irrigation (Figure II-1). In the agricultural census, an "irrigated" farm is a farm reporting any irrigated land. The average irrigated farm size was 172 acres, with about 39 acres actually irrigated (Figure II-2).

The land reported as irrigated totaled 188,323 acres in 1964. The 1964 Census of Agriculture enumerated crops grown on 172,100 irrigated acres, or about 91 percent of the total acreage reported. Of the irrigated acreage enumerated, pasture, hay, and silage accounted for 76,680 acres, or about 45 percent, and small grains and corn were produced on 10,740 acres, or about 6 percent. All of the forage crops and a substantial portion of the small grains and corn were used in the production of livestock. Vegetables, fruits, potatoes, hops, mint, and sugar beet seed were produced on 80,210 acres, or about 47 percent of the irrigated acreage enumerated. A detailed summary of irrigated land uses is presented in Table II-15.

Production and Value

Crop and livestock production associated with irrigation in the basin grossed about $61.4 million in 1964. The value of crop production ($52.6 million) and the sales value of livestock production ($8.8 million) is depicted in Figure II-3.

Crops

The production of irrigated crops and the yields per acre are shown in Table II-15. The comparison of irrigated production with total production shows that a high percentage of such crops as snap beans, sweet corn, strawberries, hops, mint, and sugar beet seed are irrigated. These crops return a high gross income per acre; they also require considerable investment to produce. As shown in Figure II-3,

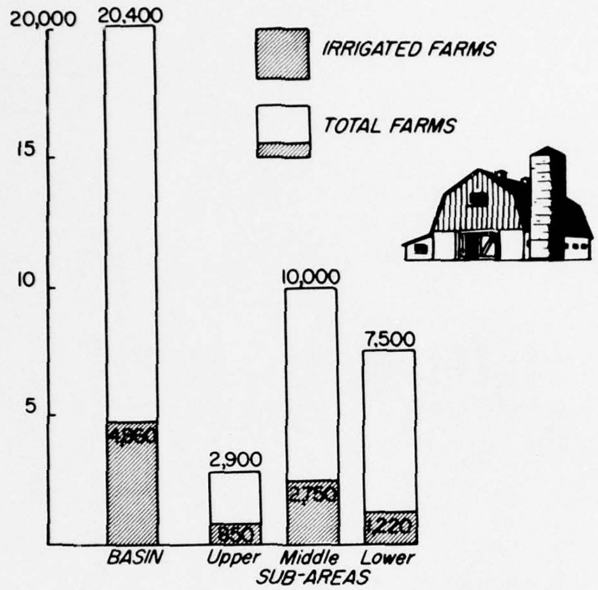


Figure II-1. Number of Farms

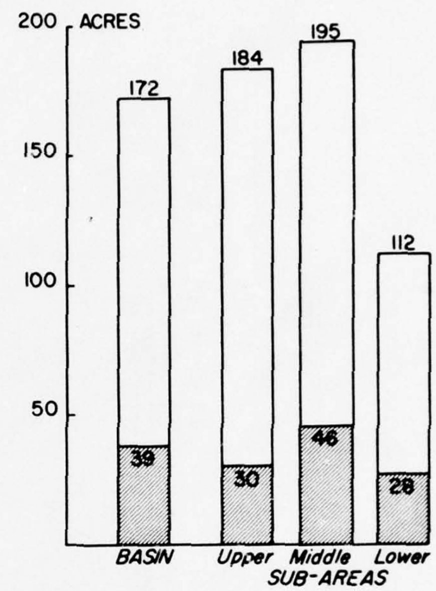
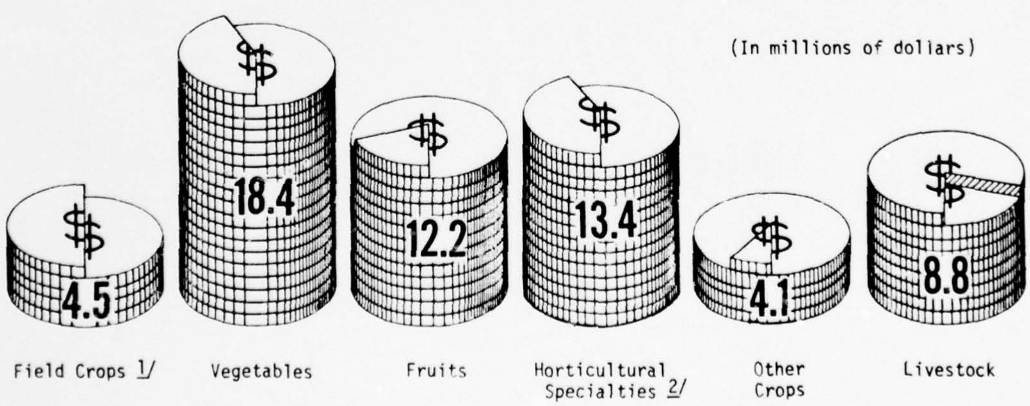


Figure II-2. Average Size of Irrigated Farms



1/ Includes seed crops, potatoes, mint, hops, and small grains sold.

2/ Includes flowers and bulbs, cut flowers, nursery stock, and vegetable seed.

Figure II-3. Value of Production from Irrigated Land, 1964

Table II-15

Irrigated Land Use, Production and Yields of Major Crops

	Irrigated Acreage 1/	Percent of Total Enumerated	Production: Total	Production: Irrigated	Production: Percent Irrigated 2/	Production: Yield Per Acre
Vegetables						
Sweet corn	20,454	11.8	21,200 acres	20,500 acres	97	5.6 tons
Snap beans	19,323	11.2	20,100 acres	19,300 acres	96	5.5 tons
Other vegetables	8,889	5.2	15,500 acres	8,900 acres	57	--
Subtotal	48,666	28.2	56,800 acres	48,700 acres	86	
Fruits						
Strawberries	7,867	4.6	42,200 tons	30,200 tons	72	3.8 tons
Caneberries	3,810	2.2	21,600 tons	7,800 tons	36	2.0 tons
Tree fruits and nuts	4,020	2.3	60,500 acres	4,000 acres	7	--
Subtotal	15,697	9.1				
Field Crops						
Small grain	6,925	4.0	273,500 tons	9,100 tons	3	1.32 tons
Field corn	3,811	2.2	12,700 tons	8,300 tons	65	2.18 tons
All hay	27,631	16.1	401,000 tons	73,800 tons	14	2.7 tons
(Alfalfa hay)	(10,623)	(6.2)	115,000 tons	41,400 tons	30	3.9 tons
(Clover hay)	(12,717)	(7.9)	188,000 tons	25,200 tons	10	2.0 tons
Silage	7,159	4.2	212,000 tons	80,300 tons	38	11.2 tons
Subtotal	45,526	26.5				
Pasture	41,894	24.4				
Other Field Crops						
Grass seeds	1,384	0.8	121,300 tons	280 tons	0.2	0.2 tons
Red clover seed	3,072	1.8	3,100 tons	530 tons	17	0.2 tons
Potatoes	1,088	0.6	584,000 Cwt	200,000 Cwt	34	183.0 Cwt
Hops	3,464	2.0	4,903,000 lbs	4,841,000 lbs	99	139.7 lbs
Mint	8,761	5.1	467,000 lbs	465,800 lbs	100	53.0 lbs
Sugar beet seed	2,535	1.5	6,556,000 lbs	6,556,000 lbs	100	2,586 lbs
Subtotal	20,304	11.8				
Total enumerated	172,087	100.0				
Other crops not enumerated	16,236					
Total irrigated	188,323					

1/ *1964 Census of Agriculture*
2/ *Based on production*

vegetable production accounts for nearly one-third of the total irrigated crop sales. Sales of irrigated fruit and horticultural specialties -- flower bulbs, cut flowers, and vegetable seeds -- together grossed about half the total. The remaining 17 percent was about equally divided between field crops and unidentified crops. The value of all crop production from irrigated land amounted to $52.6 million.

Livestock Production

The use of irrigated lands to support livestock is of major importance. In 1964, about half of all irrigated land was used to produce livestock feed crops, including hay, pasture, silage, and grains. About 14 percent of the total livestock feed requirement for the basin was produced on irrigated lands. Since all livestock and livestock products sold grossed over $63 million, livestock production supported by feed crops grown on irrigated land returned $8.8 million in sales.

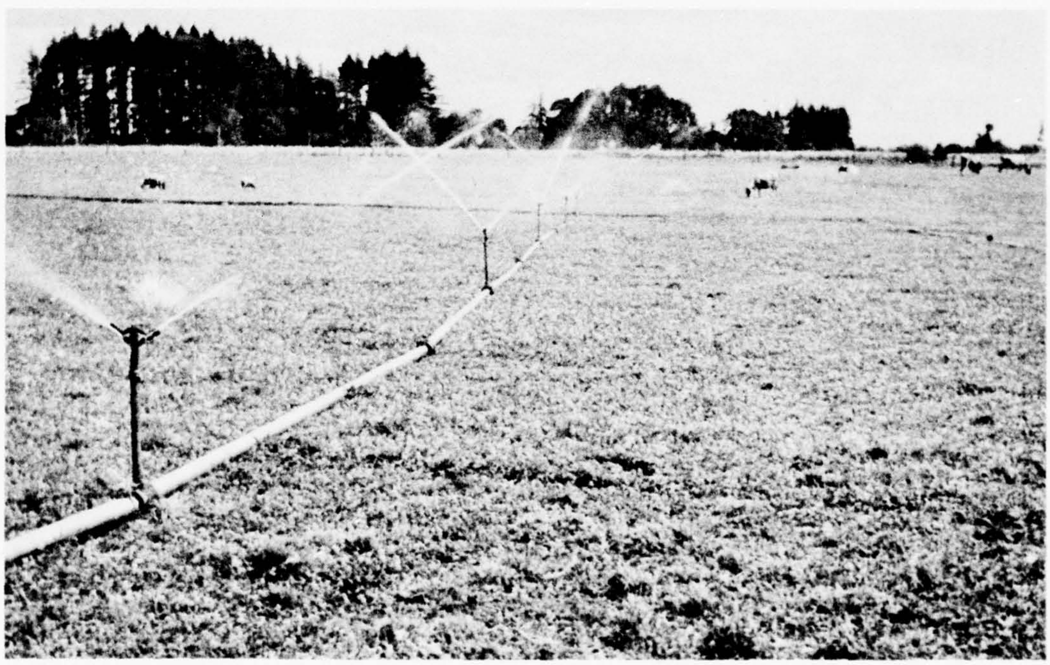


Photo II-6. Irrigated dairy pasture in Marion County. In 1964, about half of all irrigated land was used to produce livestock feed crops.

Markets and Transportation

Most of the products from irrigated lands in the basin are marketed locally for processing. A well-developed complex of processors, located conveniently to the producers, facilitates the marketing of agricultural products. The number and type of processing concerns in 1964, serving irrigated agriculture, are summarized in Table II-16. Firms with seed cleaning and processing as their primary activity are not included; however, several are known to be operating in the basin. (See Economic Base, Appendix C.)

Table II-16
Processors of Agricultural Products, 1964

Type	Upper Subarea	Middle Subarea	Lower Subarea	Willamette Basin
Livestock	9	16	29	54
Dairy	5	12	15	32
Poultry	1	3	6	10
Canning & preserving fruits & vegetables	8	31	38	77
Grain mill products	3	13	19	35
Other	7	15	66	88
Total	33	90	173	296

Source: Directory of Oregon Manufacturers and Buyers Guide

Highways and railroads are available for moving agricultural products to the processor. Trucking is most important because hauls are usually short. Many farmers use their own trucks to haul their produce to the processor; in 1964 there were 23,740 trucks on farms in the basin. In addition, many independent truck owners and several large freight trucking companies haul agricultural produce to market.

Two major railroads operate throughout the basin. Direct rail outlet is available to southwestern markets. Also, many branch lines throughout the basin connect with other railroads at Portland for northern and eastern markets. Portland is also a major port for worldwide water transportation. These facilities are of importance mainly for moving processed products to consumer markets.

I R R I G A T I O N   P O T E N T I A L

The potential for irrigation expansion in the Willamette Basin is surpassed by few areas in the Nation. An abundant water supply of excellent quality, well over one million acres of fertile land well suited for irrigation development, a favorable climate for production of a wide variety of irrigated crops, and a favorable economic and social environment are all conducive to the growth of irrigation. Also, some forest lands may be well suited to irrigation for increase of wood fiber crops. Planning work to develop these resources is continuously being done by the Soil Conservation Service, Bureau of Reclamation, and other public and private agencies. Potentially irrigable land remaining for development is limited in a broad sense by physical considerations, but urban expansion and other cultural factors are also pertinent.

LAND CHARACTERISTICS

The Willamette Basin is naturally divided into the Coast Range, the Willamette Basin, and the Cascade Range. Potentially irrigable lands are located mostly in the valley proper, but some are also found on the intervening hills and outlying foothills of the Coast and Cascade Ranges.

Photo II-7. A patchwork of irrigated and dry farm lands, such as this Marion County scene, is common in the basin.

On the basis of parent material, there are two general groups of soils in the valley. The first group, found in the outlying Chehalem, Salem, and Eola Hills and in the foothills around the valley perimeter, was formed largely from parent materials derived from igneous rock and tuffaceous sandstone, siltstone, and shale. These soils are located on gentle to moderately steep slopes; they are moderately fine-textured, and in most cases fairly deep over the underlying rock. They are generally well drained, and most of them are medium or strongly acid in reaction.

The second group -- the most extensive and most important agronomically -- is found in the lowland portions of the valley. These lowlands cover broad areas, occasionally interrupted by intervening hills. This large, contiguous expanse of smooth land characteristically has suitable soils and a favorable climate for a highly diversified agricultural economy. These lowland soils are formed from water-laid sediments of coarse to fine texture, with medium to fine the most common. Drainage ranges from poor to excessive. Lands for the most part are nearly level, but in a few locations slopes are quite steep. The soil varies from slightly to strongly acid in reaction.

Physiographically, the lowland soils can be separated into three segments, on the basis of land form and age of deposition. They are:

1. The <u>recent sediments</u> adjacent to the major streams and on the low terraces.

The soils formed from the recent sediments have textural characteristics that conform closely to the parent material from which they developed. The soil profiles vary from no development to weak development, and they are moderately shallow to very deep. They make up the Camas-Chehalis-Wapato association. The well-drained, recent alluvial soils are suitable for the production of a wide variety of crops, including nuts, tree fruits, berries, alfalfa, and row crops. Those with restricted drainage are best suited for pasture, hay, grains, and grass seed.

2. The broad valley floor deposit of water-laid, silty materials commonly referred to as the <u>Willamette Silts Terrace</u>.

The soils formed on these middle-aged sediments which underlie much of the main valley floor usually have deep silt or clay profiles. These soils constitute the Willamette-Amity-Dayton association. There are minor areas of stream terrace with soils having moderately shallow to deep profiles of gravelly soil material. They are in the Sifton-Salem-Clackamas-Courtney association. The well-drained soils are suitable for a wide variety of crops, including nuts, tree fruits, berries, alfalfa, and row crops. Those with poor drainage are best suited for the production of pasture, hay, cereal crops, and grass seed.

3. The remnants of higher gravelly terrace deposits which occur predominantly along the margins of the valley; these remnants were deposited during several geologic periods.

The soils formed from these older sediments are underlain by gravel and have varying amounts of gravel throughout the profile. This group of soils is represented by the Santiam and Gilkey Series. They are used for the production of cereal grains, grass seed, strawberries, pasture, and timber.

DETERMINATION OF IRRIGATION POTENTIAL

As part of this study, an irrigability land classification field survey of the basin was initiated in 1964 and completed in 1966(base year 1965). The primary objectives of this survey were to determine the extent of potentially irrigable lands, and to class these lands as to their suitability for irrigation. The survey results are presented on various maps and tables in this appendix.

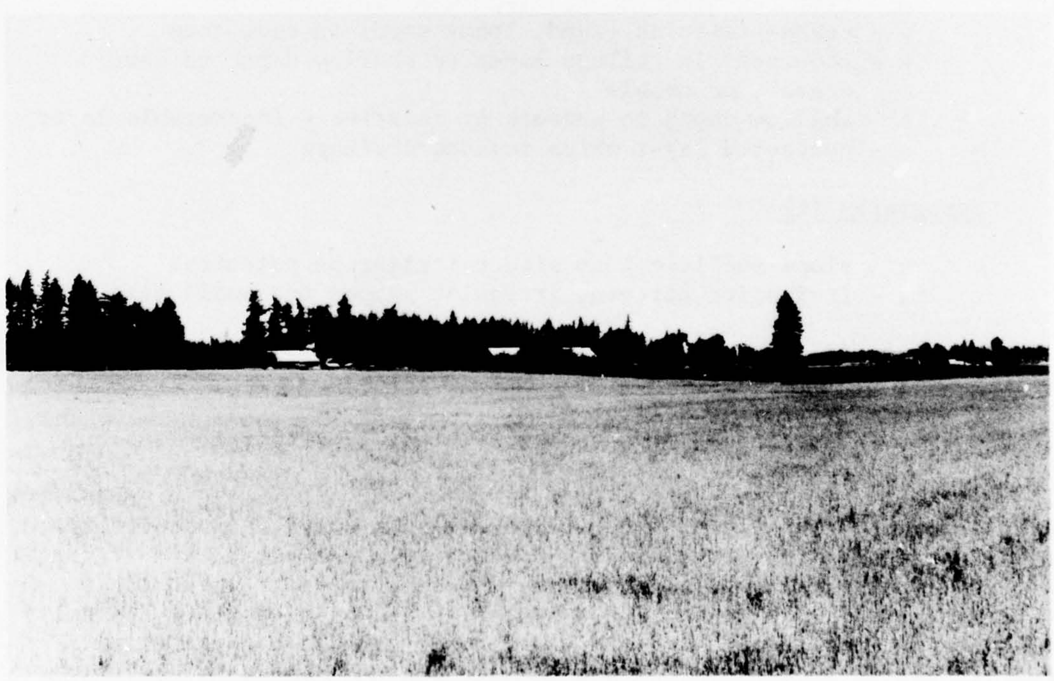


Photo II-8. This view of dryland farming in the Silverton area is typical of much of the potentially irrigable land in the valley.
(U.S. Bureau of Reclamation Photo)

The classification is based on the land's potential for sprinkler irrigation because this method is used by most Willamette Valley irrigators. Lands with slopes up to 20 percent are generally classed as potentially irrigable provided soil profile characteristics, such as soil tilth and depth over sand, gravel, or rock, are suitable for irrigation farming. Some lands with slope greater than 20 percent are included where soil depth and quality are favorable and the land fits well into the farm unit; for example, some excellent bearing orchards are located on slopes greater than 20 percent.

Land Classes

Potentially irrigable lands were mapped as class 1, 2, or 3, depending upon their relative suitability for irrigation development. Appropriate subclasses, assuming sprinkler application, average managerial ability, and the provision of drain outlets where needed, are used under classes 2 and 3 to denote specific deficiencies. Subclass deficiency symbols are as follows:

Soils (s)

- h - fine textures (clay, clay loam) in root zone
- v - coarse textures (sand, loamy sand) in root zone
- k - stoniness in tillage layer or shallow depth to sand, gravel, or cobble
- b - shallow depth to bedrock or relatively impermeable layer
- p - compacted layer which impedes drainage

Topography (t)

- g - slope sufficient to affect irrigation potential
- j - irrigation pattern, irregular shaped and small size fields

Drainage (d)

- w - wetness in soil profile
- f - flooding of magnitude sufficient to affect irrigation potential

A typical subclass symbol, 2sd-pw, identifies a class 2 land with minor soil - drainage (sd) deficiency; specifically a compacted zone or fragipan (p) in the soil profile which may cause a temporary water table buildup (w). This symbol, 2sd-pw, describes a typical soil of the Amity or Aloha Series. Subclass symbol 2d-f designates land of excellent quality but is subject to occasional flooding which affects operating costs, crop adaptability, or long-term average yield. Typical of this subclass are soils of the Cloquato Series. Table II-17 lists the characteristics of the principal subclasses of both irrigated and potentially irrigable lands.

Table II-17
Summary of Characteristics of Principal Irrigability Subclasses, Willamette Basin, 1965

Land Class and Subclass	Irrigated (Percent)	Potentially Irrigable (Percent)	Slope (Percent)	Soil and Drainage Characteristics: Principal Soil Deficiency	Infiltration	Permeability	Available Water Holding Capacity	Minimum Effective Root Zone (inches)	Tilth	Runoff	Soil Drainage	Flooding Hazard	Irrigation Characteristics: Rate of Irrigation Application	Frequency of Irrigation Application	Water Application Efficiency	Labor Requirements	Recommended Crops With Irrigation
Class 1	43.1	21.4	0-8	none	moderate	moderate	high	48	good	slow	good	none	medium	medium	medium	moderate	all
2s-h	4.2	11.2	0-8	fine texture	moderate	moderate-mod. slow	high	36-48	fair	slow	good	none	medium	medium	medium	moderate	all
-v	7.2	0.7	0-4	coarse texture	mod. rapid	moderate-mod. rapid	moderate-low	48	good	very slow	somewhat excessive	none	mod. high	mod. high	mod. low	moderate	all
-k	3.3	1.2	0-4	gravelly	mod. rapid	moderate-mod. rapid	moderate	48	fair	very slow	somewhat excessive	none	medium	mod. high	mod. low	moderate	all
2t-g	0.5	1.1	8-14	none	mod. slow	moderate	high	48	good	medium	good	none	medium	medium	mod. low	mod. high	most-close growing
2d-f	4.8	1.1	0-4	none	moderate	moderate	high	48	good	slow	mod.good-good	moderate	medium	medium	medium	mod. high	most
2sd-hw	3.0	3.4	0-4	fine texture	moderate	mod. slow	high	48	fair	slow	imper-fect	none	medium	medium	medium	mod. high	most
-pw	9.3	11.4	0-4	restrict-ing layer	mod. rapid	mod. slow	high	48	good	slow	imper-fect	none	medium	medium	medium	moderate	most
-hwf	2.5	1.3	0-4	fine texture	moderate	mod. slow	high	48	fair	slow	imper-fect	minor	medium	medium	medium	mod. high	most
-vf	2.7	0.6	0-4	coarse texture	mod. rapid	moderate-mod. rapid	moderate-low	48	good	very slow	somewhat excessive	moderate	mod. high	mod. high	mod. low	mod. high	most
2st-hg	0.9	3.5	8-12	fine texture	moderate-mod. slow	moderate	high	48	fair-good	medium	good	none	medium	medium	mod. low	mod. high	most-close growing
Class 2	38.4	35.5															
3s-b	0.2	0.9	0-8	shallow depth	moderate	moderate	low	20	fair	slow	mod.good	none	medium	mod. high	mod. low	moderate	shallow rooted
-v	0.8	0.1	0-4	coarse texture	rapid	mod. rapid-rapid	low	48	good	very slow	somewhat excessive	none	high	high	low	mod. high	most
-k	1.2	0.6	0-8	very gravelly	rapid	rapid	low	20	poor	very slow	somewhat excessive	none	mod. high	high	low	mod. high	most
3t-g	0.2	0.3	14-20	none	mod. slow-slow	moderate	high	48	good	rapid	good	none	medium	mod. high	low	high	close growing
3sd-hw	6.7	18.9	0-4	fine texture	mod. slow	slow	very low-high	18	fair-poor	very slow	poor	none	medium	medium	medium	mod. high	close growing-shallow rooted
-kw	2.3	0.3	0-4	gravelly	mod. rapid	mod. rapid	low to moderate	48	poor-fair	very slow	poor-imperfect	none	medium-high	mod. high	mod. low	mod. high	shallow rooted
-hwf	4.9	4.9	0-4	fine texture	mod. slow	slow	high	18	fair-poor	very slow	poor	minor	medium-low	medium	medium	high	close growing-shallow rooted
-vf	0.9	0.2	0-4	coarse texture	rapid	mod. rapid-rapid	low	48	good	very slow	exces-sive	moderate	high	high	low	mod. high	annual
-kf	0.3	0.2	0-4	very gravelly	rapid	rapid	very low	20	poor	very slow	somewhat excessive	moderate	high	high	low	mod. high	annual
3st-hg	0.7	9.4	12-20	fine texture	mod. slow	moderate-mod. slow	high	48	fair	rapid	good	none	low-medium	medium	low	high	close growing
-hg	0.3	7.3	12-20	shallow	mod. slow	moderate	low	20-30	fair	rapid	good	none	low	mod. high	low	high	close growing-shallow rooted
Class 3	18.5	43.1															
	(100)	(100)															

Lands mapped as class 1 total 318,440 acres or 21 percent of the potentially irrigable lands in the basin. They are of excellent quality, suitable for profitable production of all climatically adapted crops under irrigation. They are deep, medium-textured, have easily worked soils with good drainage characteristics, and occur in large bodies which lend themselves to irrigation farming. Most of the class 1 lands include soils of the Willamette, Woodburn, Cloquato or Chehalis Series. About 43 percent of the presently irrigated lands are of class 1 quality.

Class 2 lands total 528,440 acres or about 36 percent of the potentially irrigable acreage. They are represented by five main subclasses, all of fairly good quality and capable of profitable production of most climatically adapted crops under irrigation. However, they have one or more minor deficiencies which slightly affect their crop adaptability or yield, increase production costs, or require farm drain systems or other land development prior to irrigation. About 38 percent of the presently irrigated lands are class 2.

The class 3 lands total 641,250 acres, 43 percent of the potentially irrigable acreage. They consist of four main subclasses, all of fair quality and suitable for irrigation farming, but with rather serious deficiencies which will limit their crop adaptability under irrigation, restrict their yield potential, or increase production costs. They require special management to protect them against erosion, waterlogging or other hazards. About 19 percent of the lands now irrigated are of class 3 quality.

Some 143,200 acres within the basin lie within corporate city limits as identified from the Willamette Drainage Basin map prepared in 1964 by the Oregon State Water Resources Board.

Some 188,290 acres located outside corporate city limits and in suburban, residential, and industrial uses were delineated as R-I (residential-industrial) lands. Included in this category are unincorporated cities, golf courses, sawmills, parks, game refuges, and areas which are already subdivided or in the process of being subdivided. These areas are not considered potentially irrigable because of their present use.

A nonarable rating (class 6) is given to areas of rocky or very shallow soil, swamps, water bodies, stream channels, or other lands which are not suitable for irrigation development. Included in this class are 5,645,720 acres, most of which are in the mountainous nonagricultural areas of the basin.

Maps II-12 through II-22 show, in general, the location and distribution of the arable land. Also shown are the areas in cities, areas in residential and industrial uses, and the nonarable lands for the 11 subbasins. Land classification maps for each township containing irrigable lands are on file with the Bureau of Reclamation in Salem.

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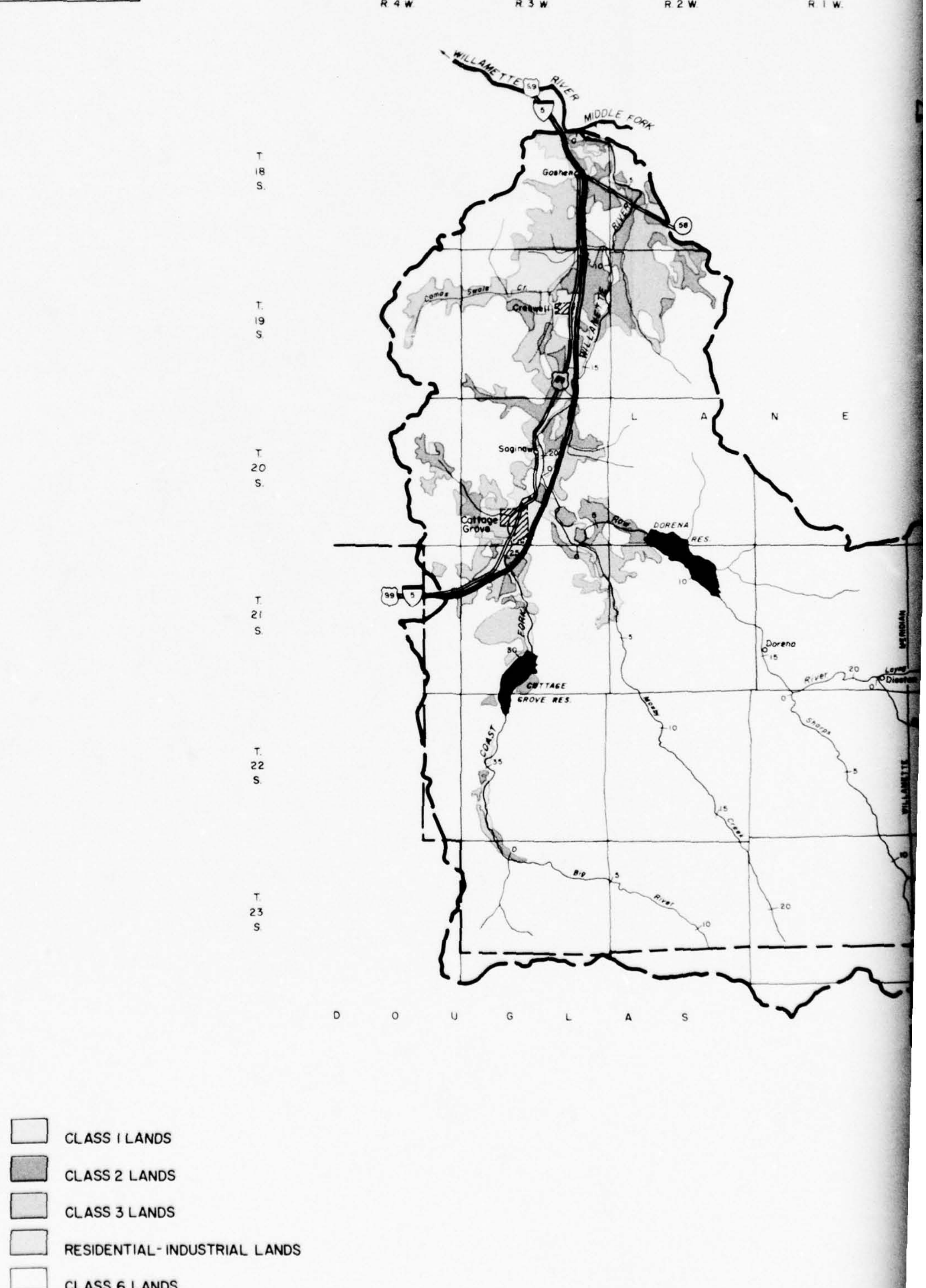
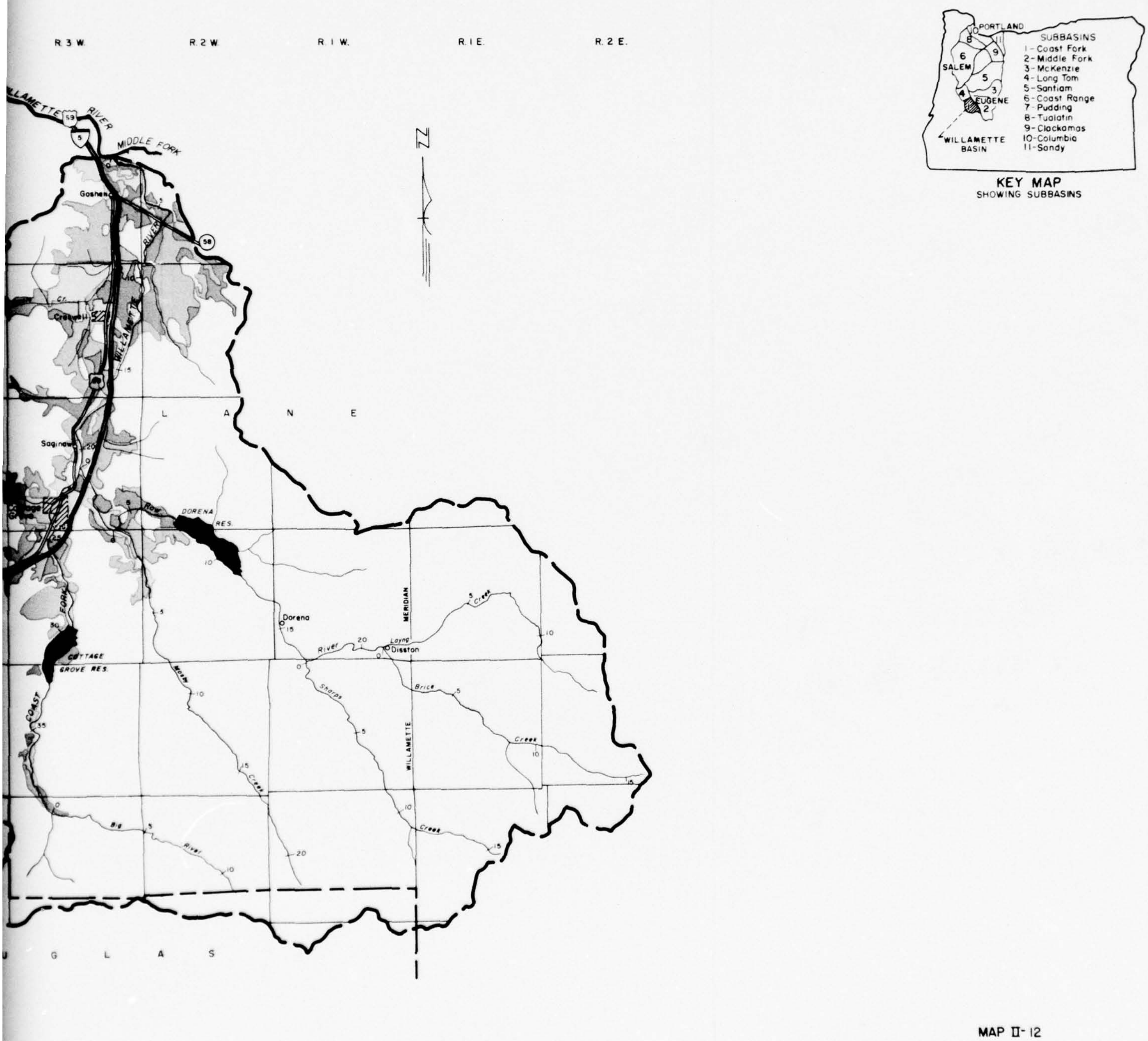
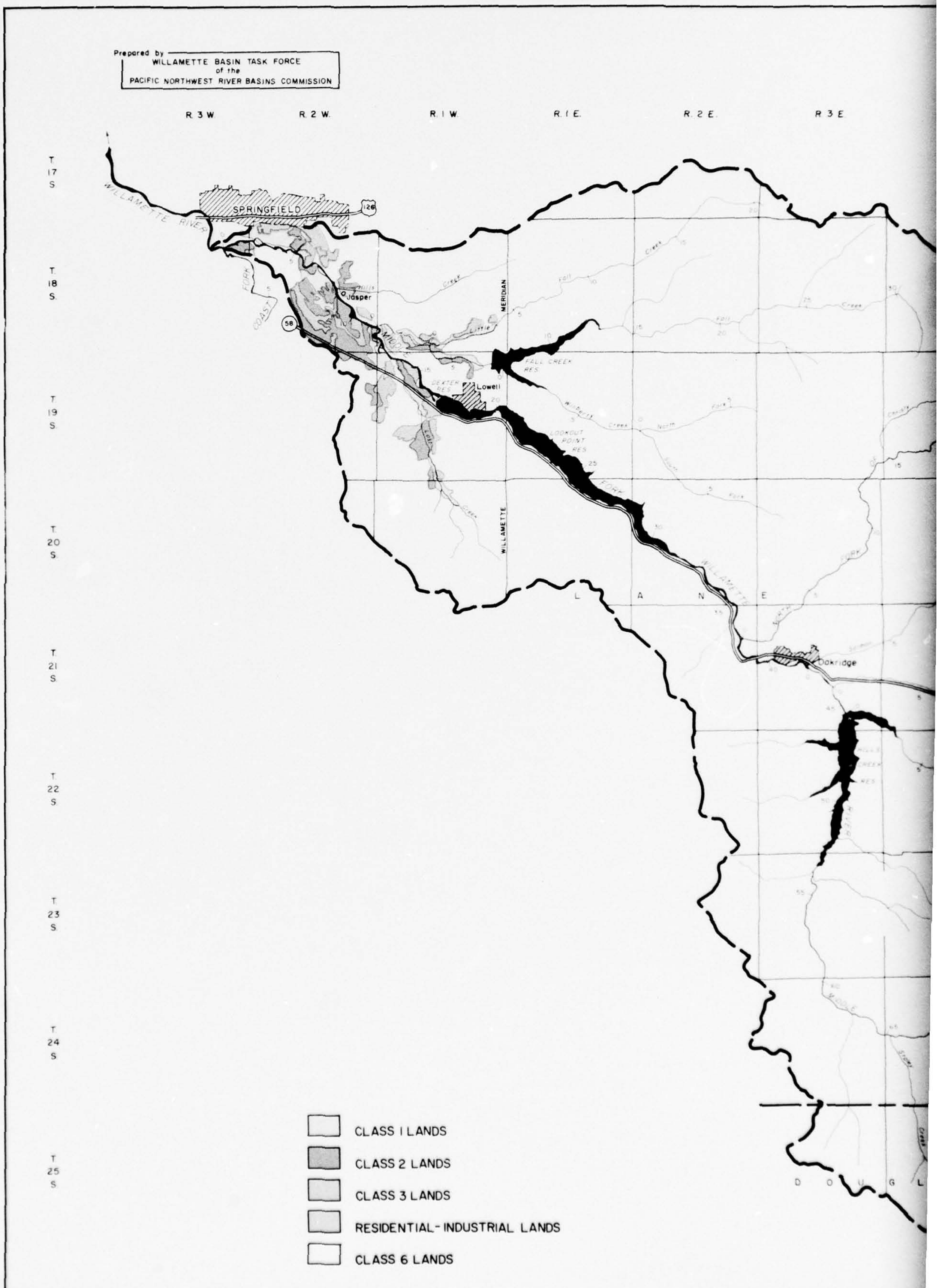




MAP II-12
COAST FORK
WILLAMETTE BASIN, OREGON
IRRIGABILITY LAND CLASSIFICATION
1965

3 0 3 6
SCALE IN MILES



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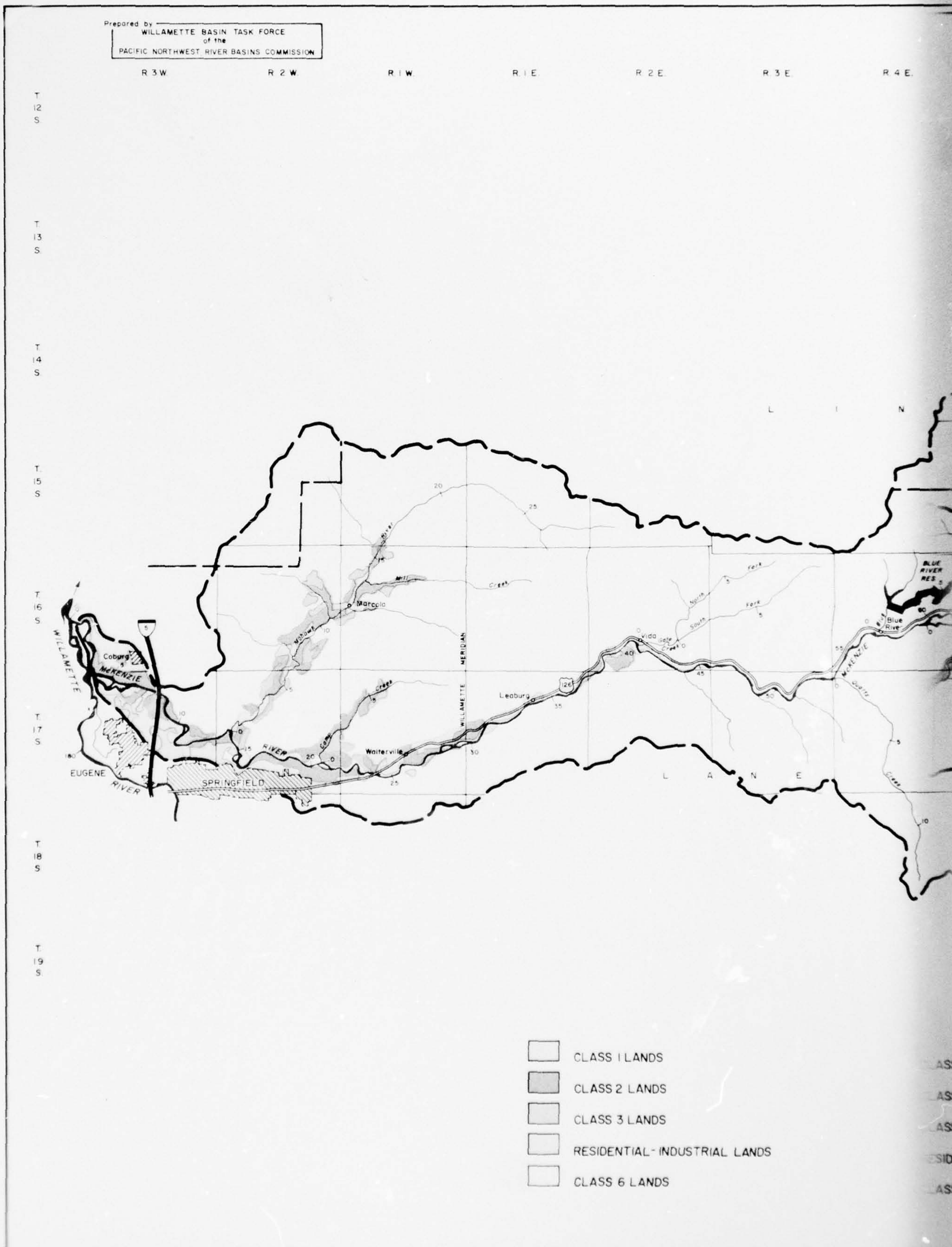
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
R. 3 E.
T. 17 S.
T. 18 S.
T. 19 S.
T. 20 S.
T. 21 S.
T. 22 S.
T. 23 S.
T. 24 S.
T. 25 S.
SPRINGFIELD
WILLAMETTE RIVER
Jasper
Lowell
Oakridge
FALL CREEK RES.
DEXTER RES.
LOOKOUT POINT RES.
HILLS CREEK RES.
MERIDIAN
WILLAMETTE
L A N E
D O U G L
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL- INDUSTRIAL LANDS
CLASS 6 LANDS

WBTF-2-1018 d-LL



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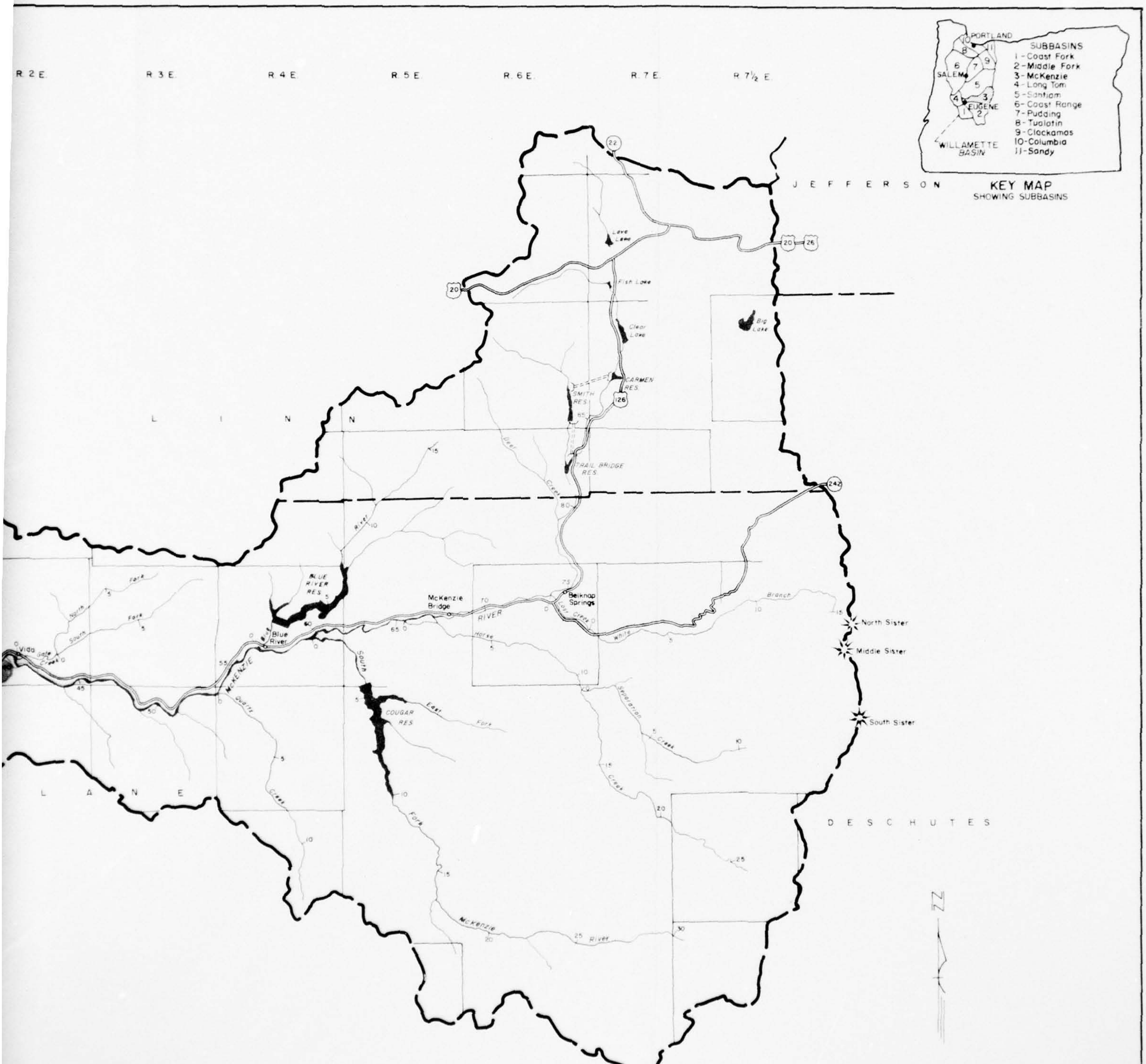
R.3W.
R.2W.
R.1W.
R.1E.
R.2E.
R.3E.
R.4E.
T. 12 S.
T. 13 S.
T. 14 S.
T. 15 S.
T. 16 S.
T. 17 S.
T. 18 S.
T. 19 S.
L I N
L A N E
BLUE RIVER RES.
Blue River
Marcola
Mohawk
Mill
Creek
North Fork
South Fork
Vida
Gate Creek
Leaburg
Walterville
Camp Creek
Coburg
McKENZIE
WILLAMETTE
RIVER
EUGENE
SPRINGFIELD
WILLAMETTE MERIDIAN
Quartz Creek
McKENZIE
126
5
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL- INDUSTRIAL LANDS
CLASS 6 LANDS



LANDS

LANDS

LANDS

TIAL-INDUSTRIAL LANDS

LANDS

MAP II-14

McKENZIE SUBBASIN

WILLAMETTE BASIN, OREGON

IRRIGABILITY LAND CLASSIFICATION

1965

3 0 3 6

SCALE IN MILES

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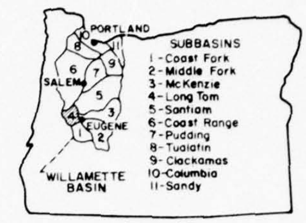
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL-INDUSTRIAL LANDS
CLASS 6 LANDS



KEY MAP
SHOWING SUBBASINS

MAP II-15
LONG TOM SUBBASIN
WILLAMETTE BASIN, OREGON

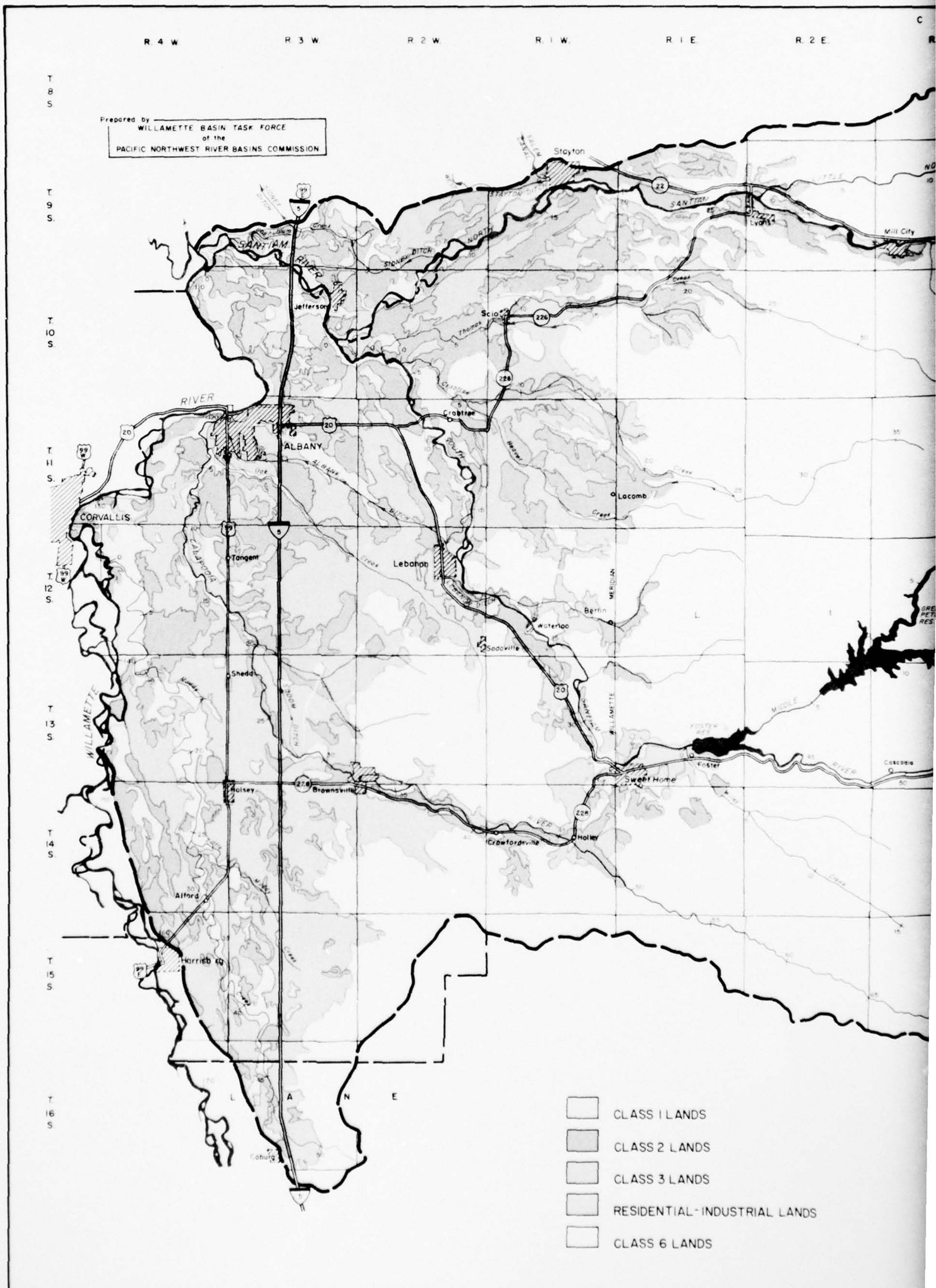
IRRIGABILITY LAND CLASSIFICATION

1965

SCALE IN MILES

2

WBTF-4-1020 d-LL



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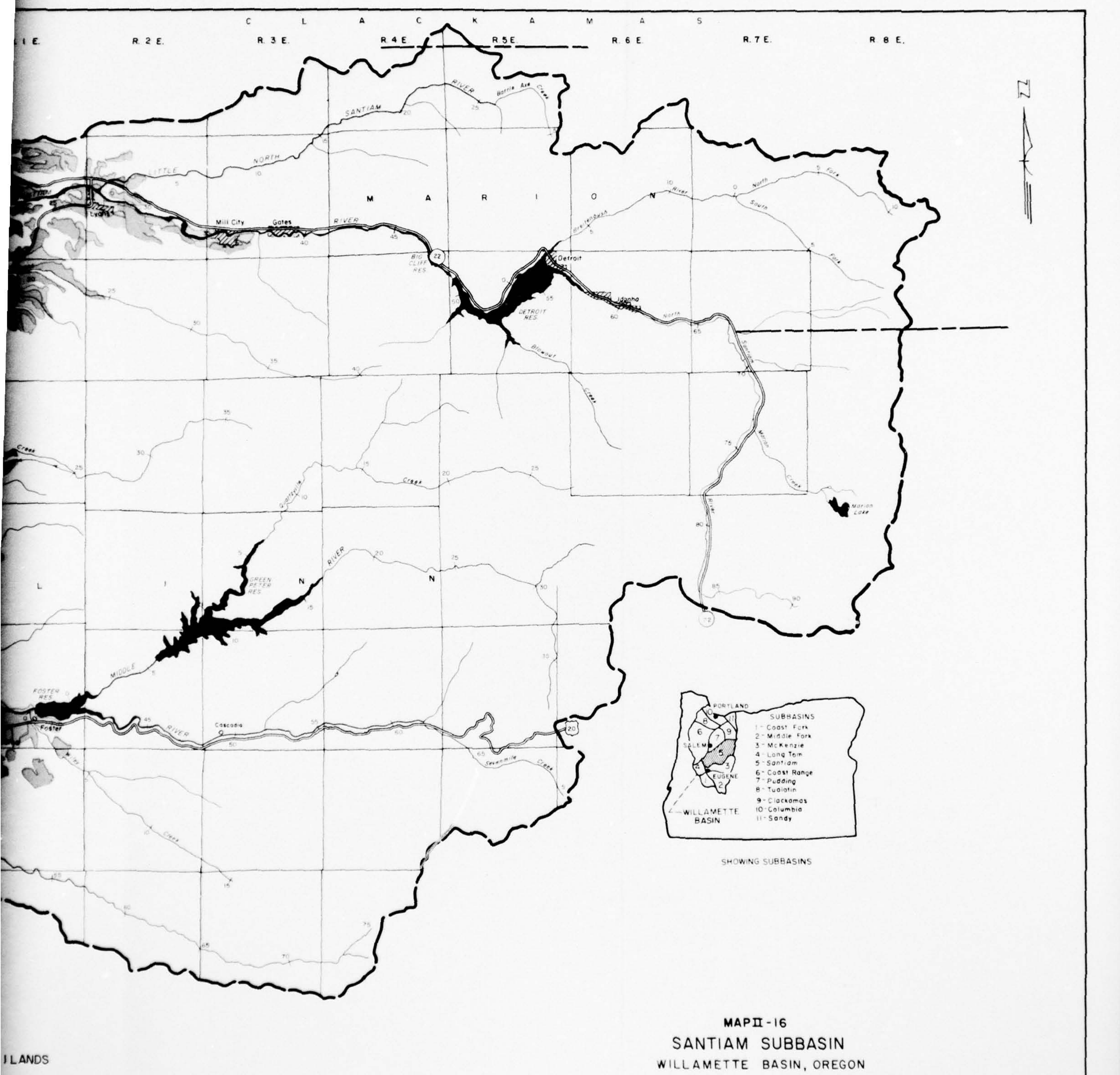
R. 4 W.
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
R. 2 E.
T. 8 S.
T. 9 S.
T. 10 S.
T. 11 S.
T. 12 S.
T. 13 S.
T. 14 S.
T. 15 S.
T. 16 S.
Stayton
Lyons
Mill City
Jefferson
Scio
ALBANY
CORVALLIS
Crabtree
Lacomb
Tangent
Lebanon
Berlin
Waterloo
Sodaville
Shedd
Halsey
Brownsville
Sweet Home
Foster
Cascadia
Crawfordsville
Holley
Alford
Harrisburg
Coburg
SANTIAM
RIVER
WILLAMETTE
CALAPOOIA
MIDDLE
L A N E
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL-INDUSTRIAL LANDS
CLASS 6 LANDS



1 LANDS

2 LANDS

3 LANDS

NTIAL-INDUSTRIAL LANDS

6 LANDS

MAP II-16

SANTIAM SUBBASIN

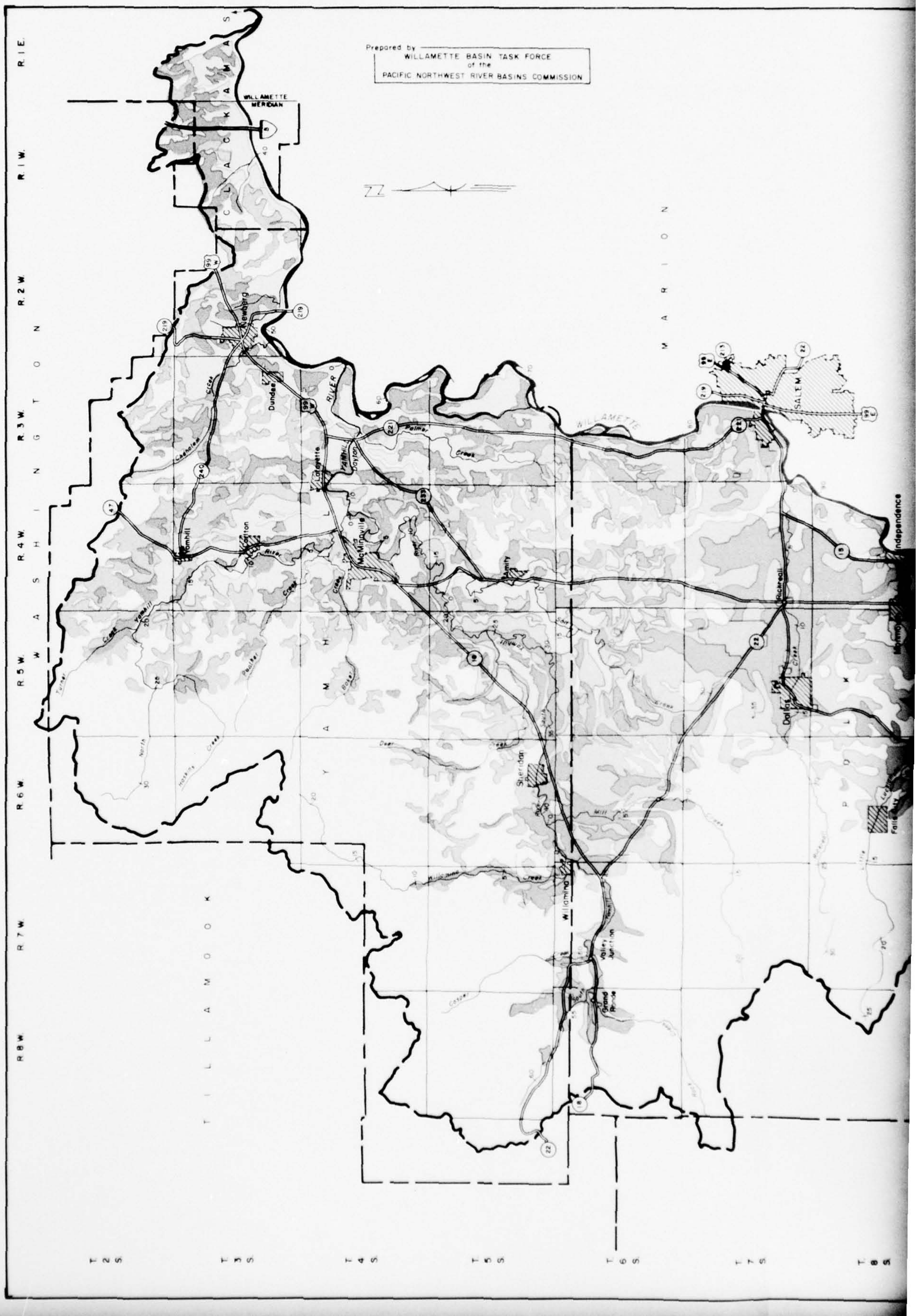
WILLAMETTE BASIN, OREGON

IRRIGABILITY LAND CLASSIFICATION

1965

SCALE IN MILES

WBTF-5-1021 d-LL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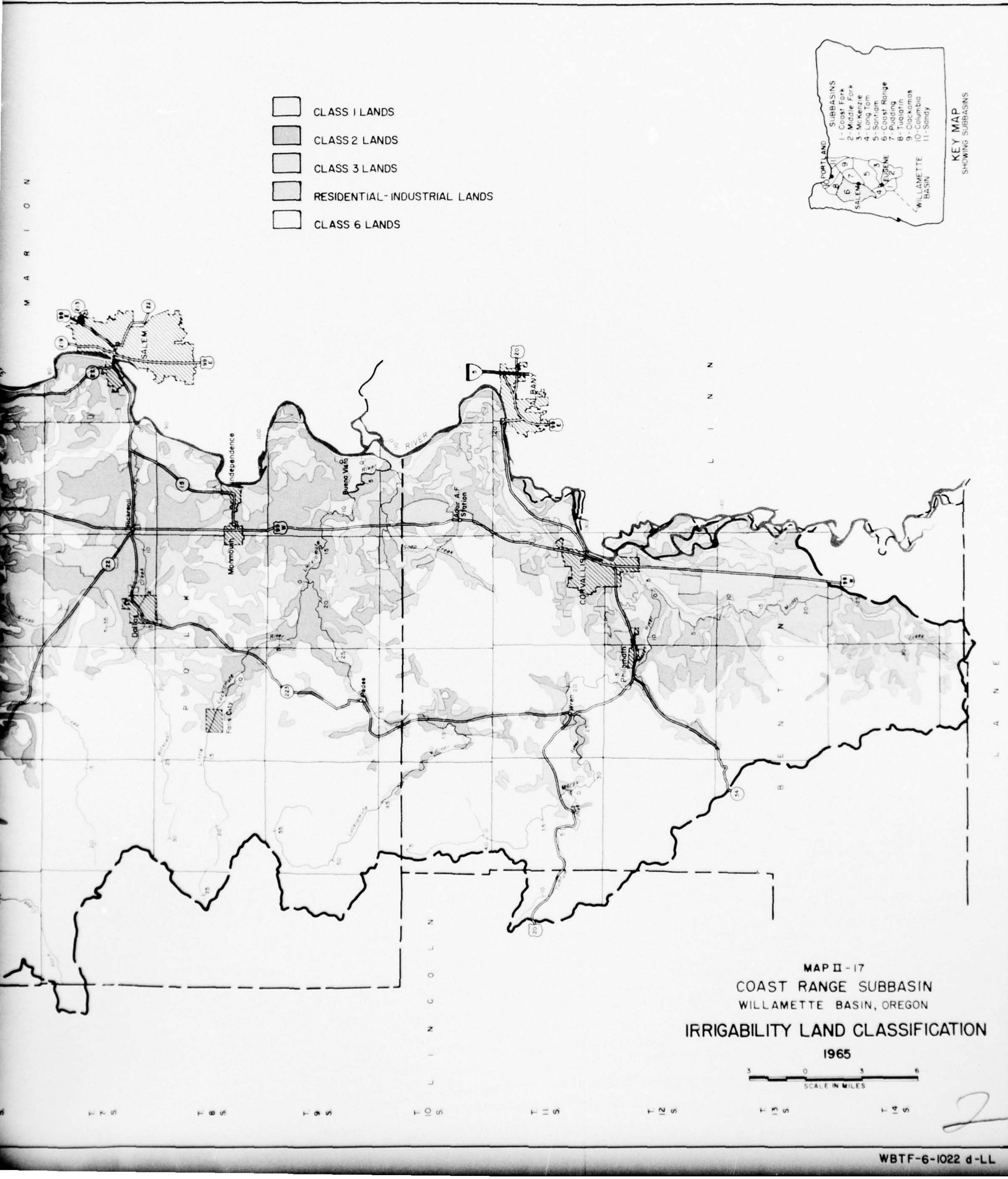
WILLAMETTE MERIDIAN
R.1E.
R.1W.
R.2W.
R.3W.
R.4W.
R.5W.
R.6W.
R.7W.
R8W.
T2S
T3S
T4S
T5S
T6S
T7S
T8S
WASHINGTON
CLACKAMAS
MARION
YAMHILL
POLK
TILLAMOOK
WILLAMETTE
RIVER
Newberg
Dundee
Lafayette
Dayton
Yamhill
Carlton
McMinnville
Amity
Sheridan
Willamina
Valley Junction
Grand Ronde
Rickreall
Dallas
Independence
Monmouth
Falls City
SALEM
Palmer Creek
Deer Creek
Mill Creek



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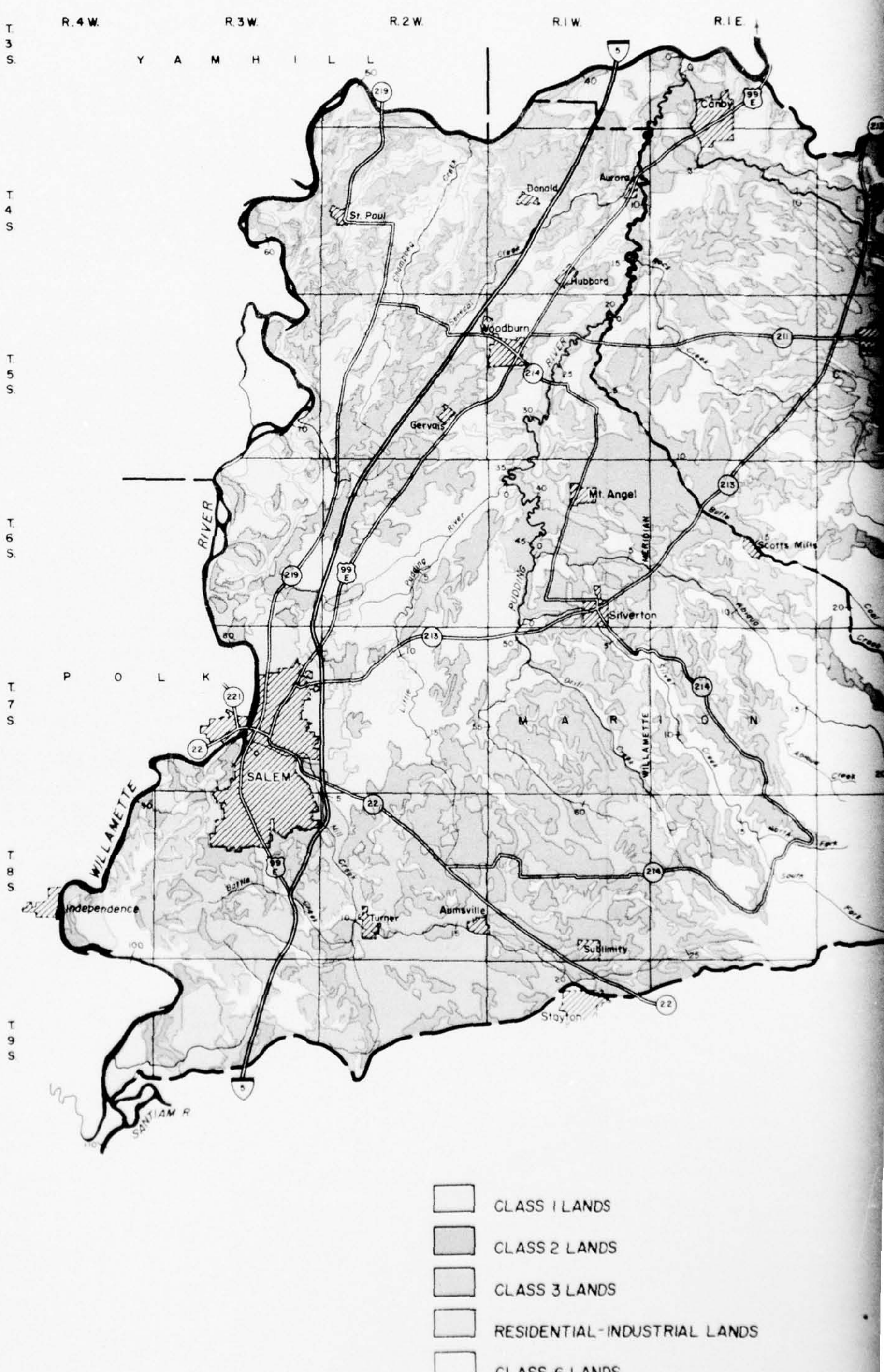
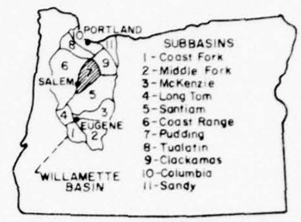
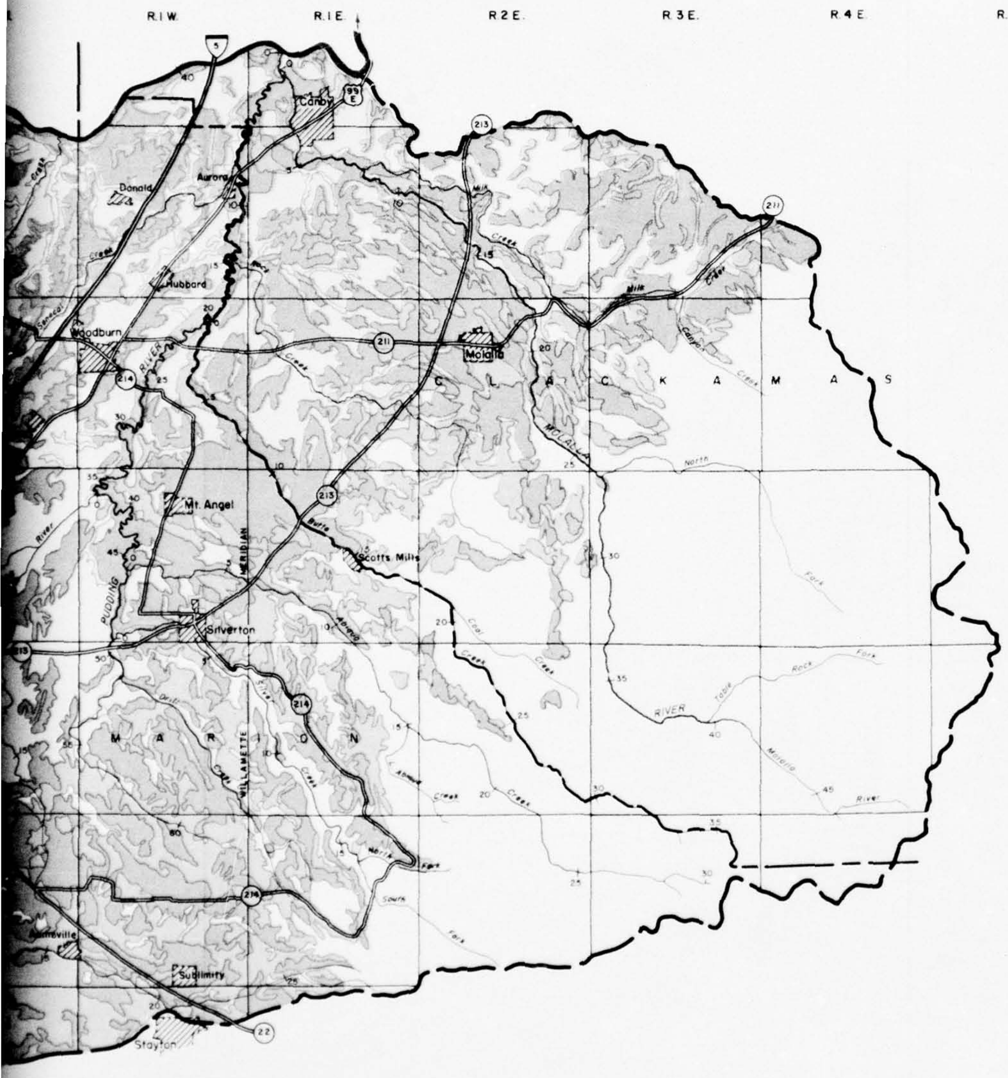




KEY MAP
SHOWING SUBBASINS



CLASS 1 LANDS

CLASS 2 LANDS

CLASS 3 LANDS

RESIDENTIAL-INDUSTRIAL LANDS

CLASS 6 LANDS

MAP II-18

PUDDING SUBBASIN

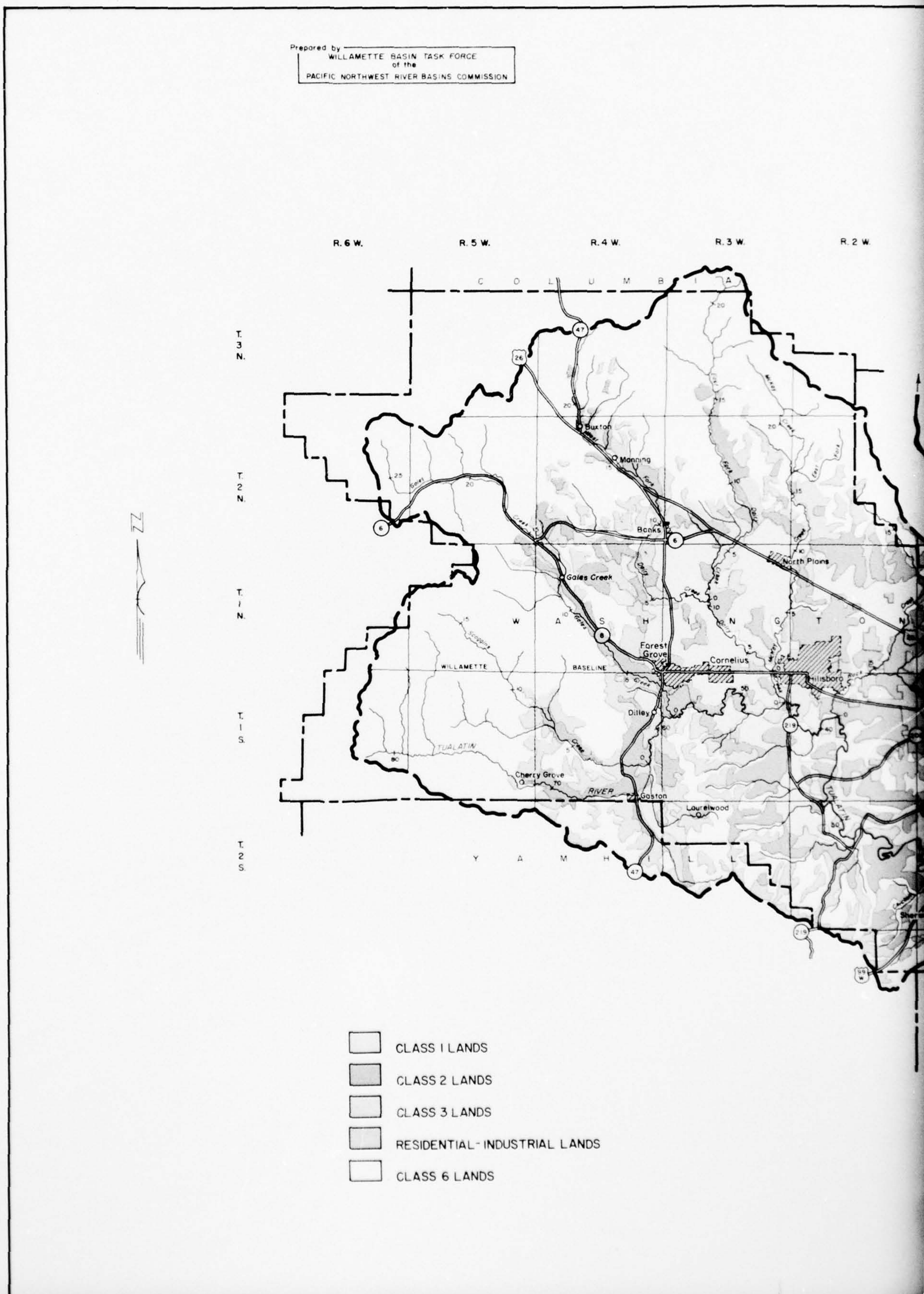
WILLAMETTE BASIN, OREGON

IRRIGABILITY LAND CLASSIFICATION

1965

3 0 3 6
SCALE IN MILES

WBTF-7-1023 d-LL



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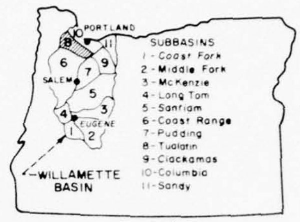
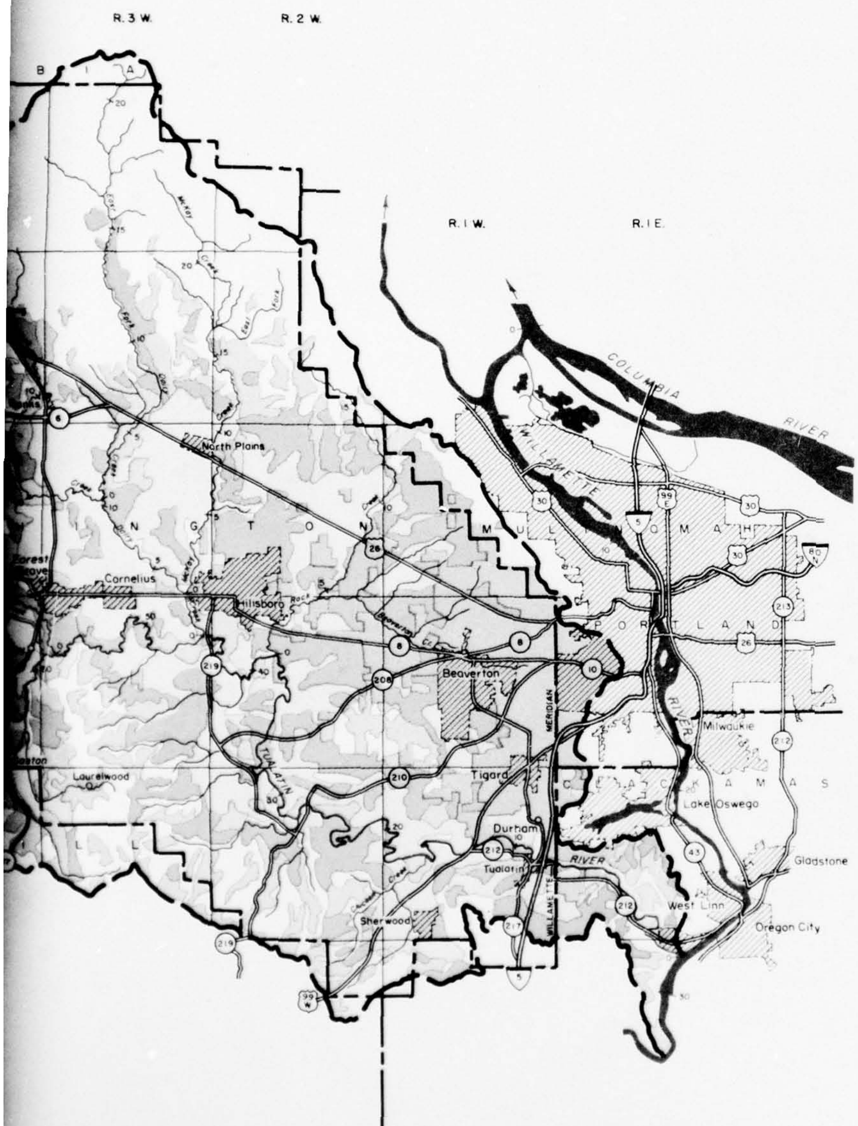
R. 6 W.
R. 5 W.
R. 4 W.
R. 3 W.
R. 2 W.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
C O L U M B I A
W A S H I N G T O N
Y A M H I L L
WILLAMETTE
BASELINE
TUALATIN
RIVER
Buxton
Manning
Banks
North Plains
Gales Creek
Forest Grove
Cornelius
Hillsboro
Dilley
Cherry Grove
Gaston
Laurelwood
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL- INDUSTRIAL LANDS
CLASS 6 LANDS



KEY MAP
SHOWING SUBBASINS



MAP II-19

TUALATIN SUBBASIN

WILLAMETTE BASIN, OREGON

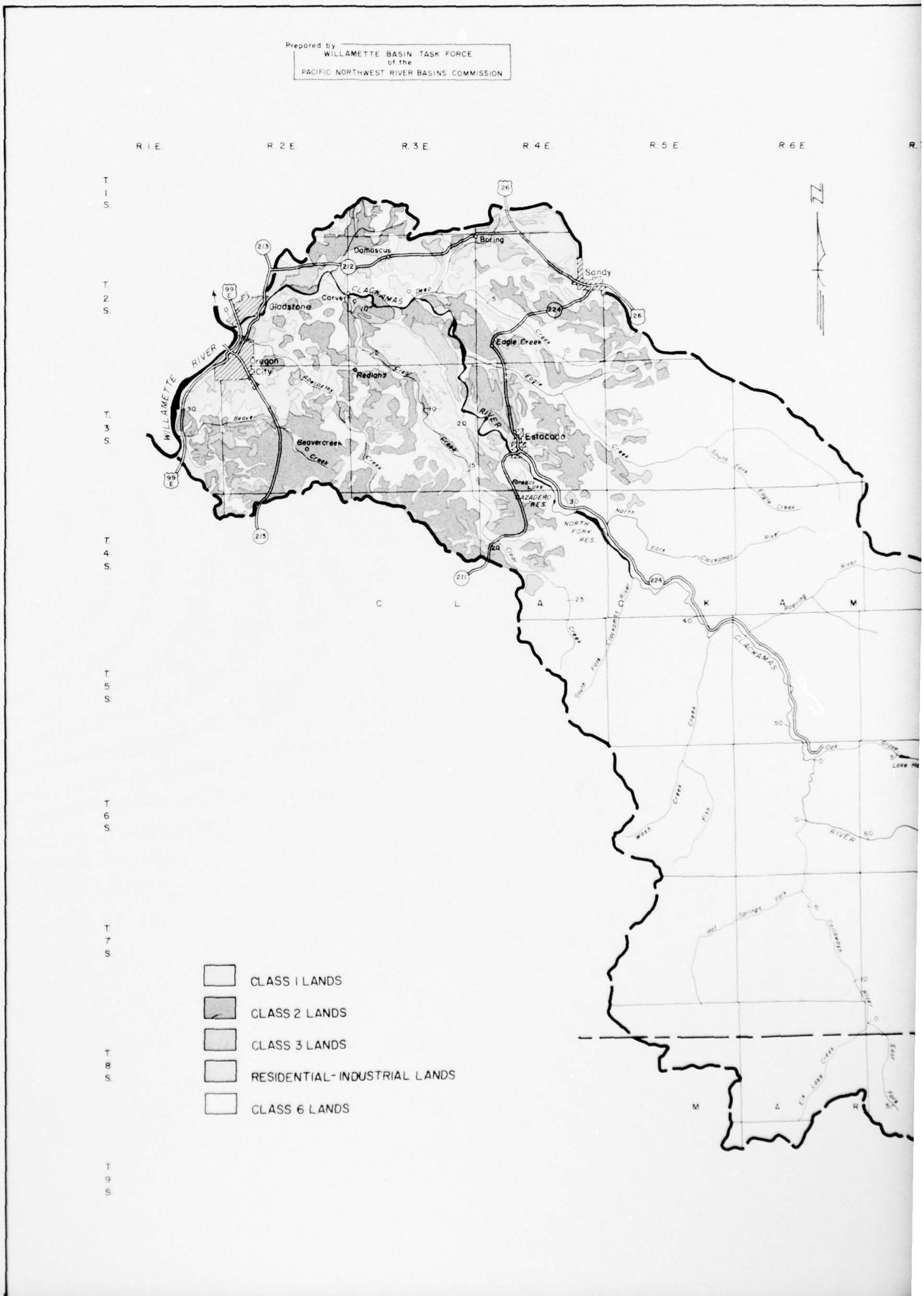
IRRIGABILITY LAND CLASSIFICATION

1965

3 0 3 6
SCALE IN MILES

2

WBTF-8-1013 d-LL



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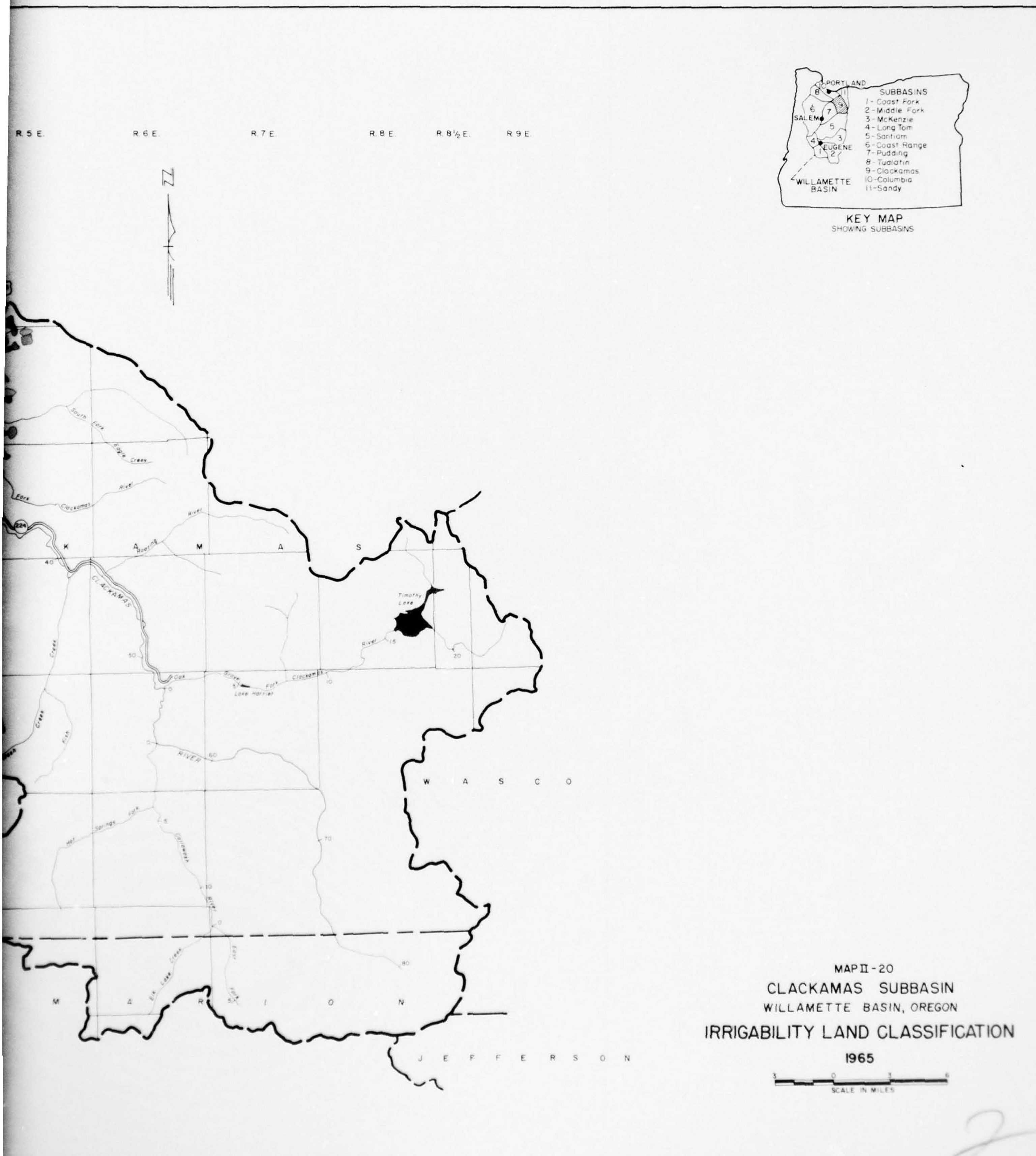
R.1 E.
R.2 E.
R.3 E.
R.4 E.
R.5 E.
R.6 E.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.
T. 7 S.
T. 8 S.
T. 9 S.
Damascus
Boring
Sandy
Gladstone
Carver
CLACKAMAS
Oregon City
Redland
Eagle Creek
Estacada
Beavercreek
WILLAMETTE RIVER
RIVER
NORTH FORK RES.
C L A K A M
CLACKAMAS
RIVER
M A R
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL-INDUSTRIAL LANDS
CLASS 6 LANDS



MAP II-20
CLACKAMAS SUBBASIN
WILLAMETTE BASIN, OREGON
IRRIGABILITY LAND CLASSIFICATION
1965

AD-A036 758   PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH   F/G 8/6
THE WILLAMETTE BASIN COMPREHENSIVE STUDY OF WATER AND RELATED L--ETC(U)
1969

UNCLASSIFIED   NL

2 OF 2
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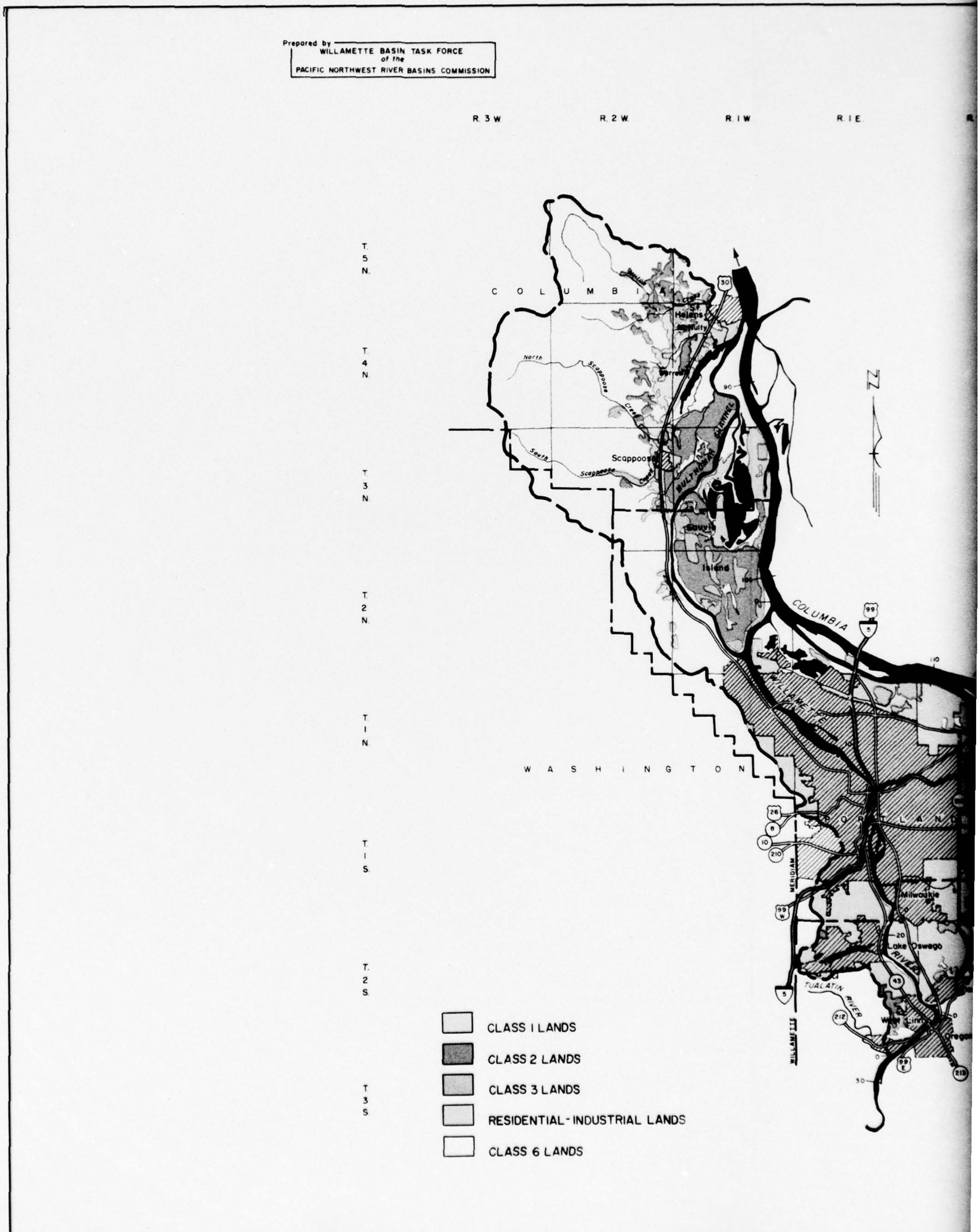
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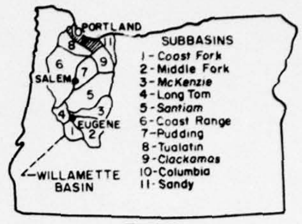
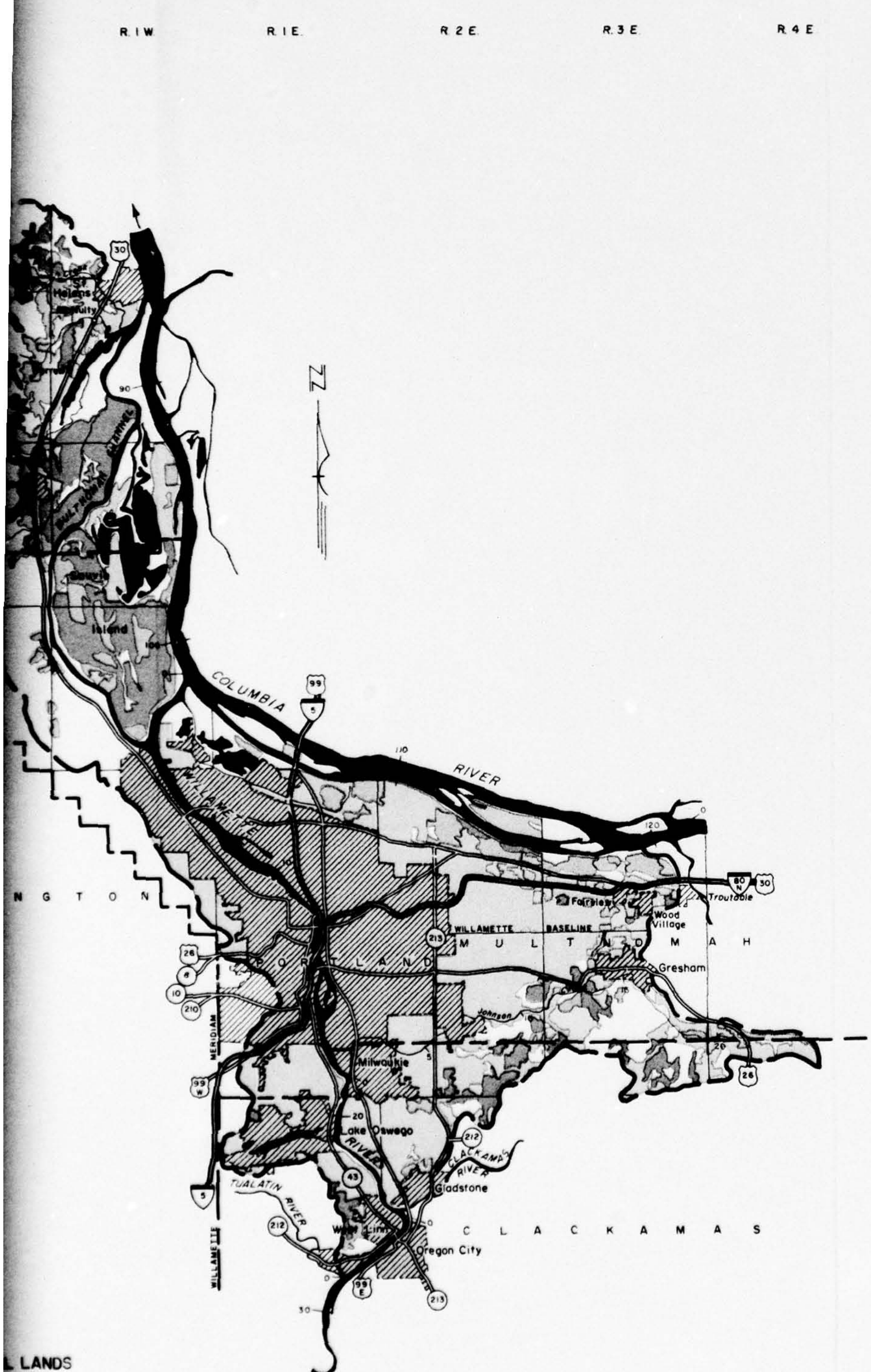
R. 3 W.
R. 2 W.
R. 1 W.
R. 1 E.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
COLUMBIA
WASHINGTON
St. Helens
Warren
Scappoose
North Scappoose Creek
South Scappoose Creek
MULTNOMAH CHANNEL
Sauvie Island
COLUMBIA
WILLAMETTE
PORTLAND
Milwaukie
Lake Oswego
TUALATIN RIVER
West Linn
MERIDIAN
WILLAMETTE
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL-INDUSTRIAL LANDS
CLASS 6 LANDS



KEY MAP
SHOWING SUBBASINS



MAP II - 21

COLUMBIA SUBBASIN

WILLAMETTE BASIN, OREGON

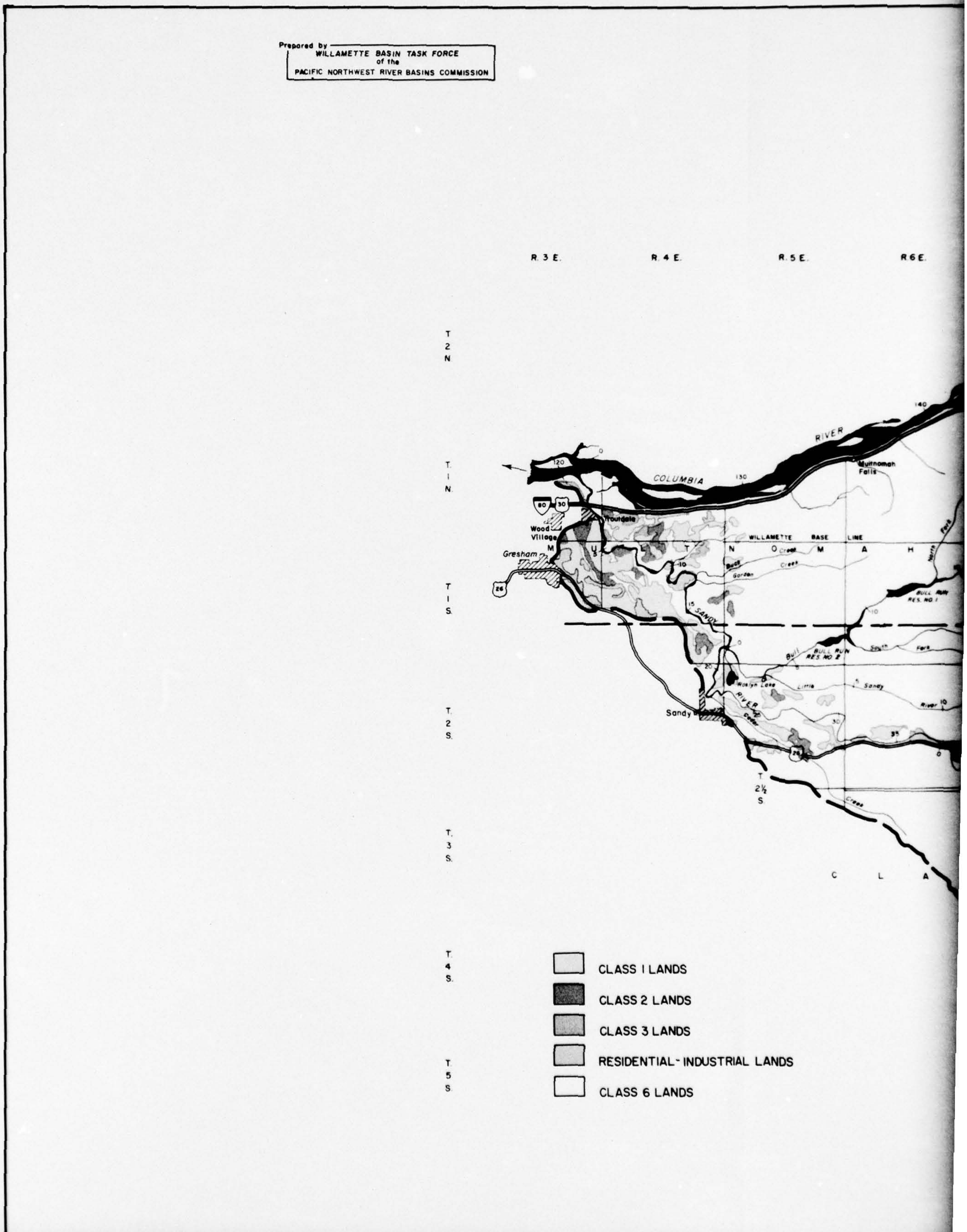
IRRIGABILITY LAND CLASSIFICATION

1965

SCALE IN MILES

2

WBTF-10-1015d-LL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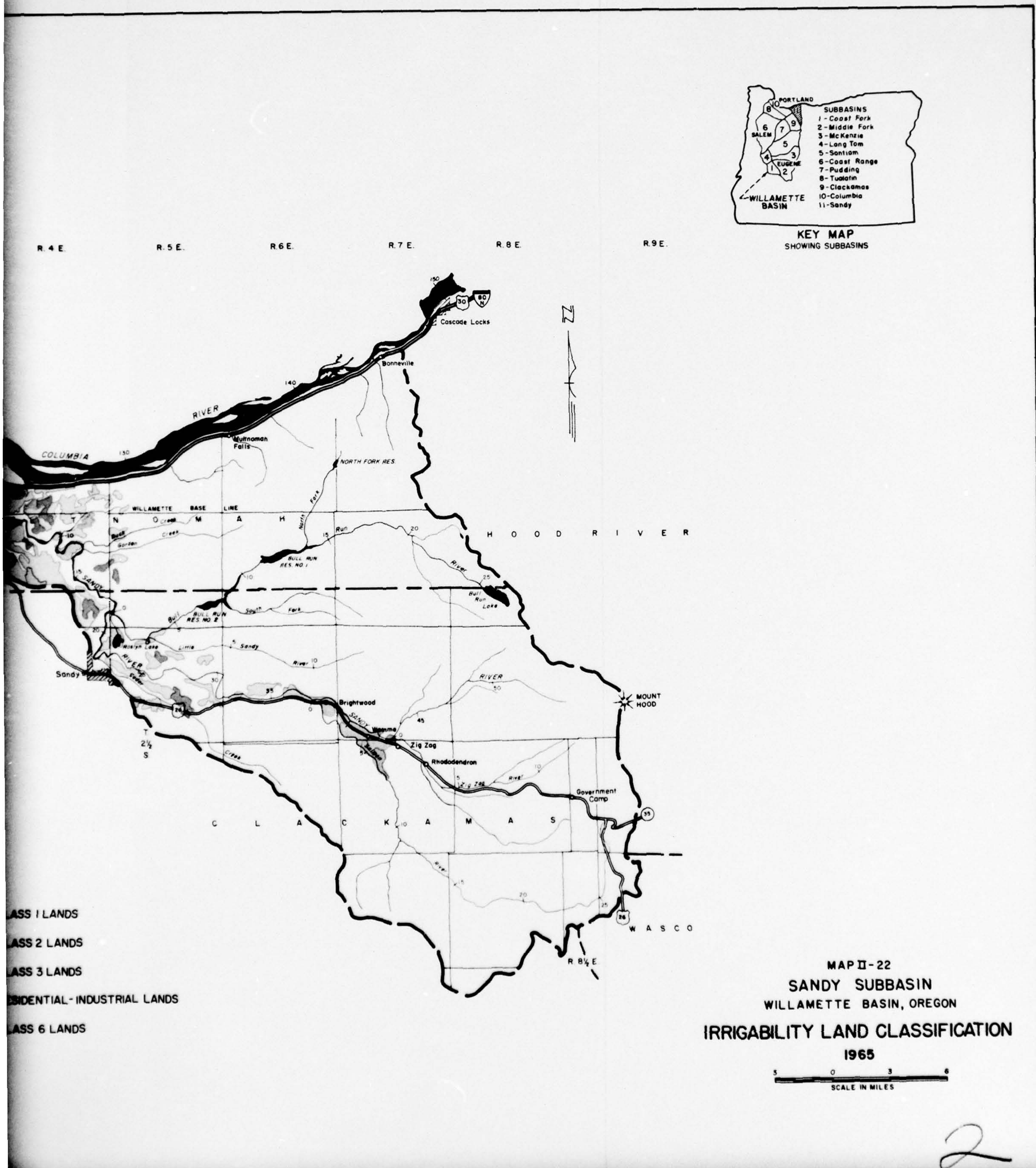
R. 3 E.
R. 4 E.
R. 5 E.
R6E.
T 2 N
T. 1 N.
T 1 S.
T. 2 S.
T. 2½ S.
T. 3 S.
T. 4 S.
T 5 S.
COLUMBIA
RIVER
Multnomah Falls
Troutdale
Wood Village
Gresham
WILLAMETTE BASE LINE
SANDY
RIVER
BULL RUN RES. NO. 1
BULL RUN RES. NO. 2
Sandy
C L A
CLASS 1 LANDS
CLASS 2 LANDS
CLASS 3 LANDS
RESIDENTIAL- INDUSTRIAL LANDS
CLASS 6 LANDS



PORTLAND
SUBBASINS
1 - Coast Fork
2 - Middle Fork
3 - McKenzie
4 - Long Tom
5 - Santiam
6 - Coast Range
7 - Pudding
8 - Tualatin
9 - Clackamas
10 - Columbia
11 - Sandy
SALEM
EUGENE
WILLAMETTE BASIN
KEY MAP
SHOWING SUBBASINS
R. 4 E.
R. 5 E.
R. 6 E.
R. 7 E.
R. 8 E.
R. 9 E.
Cascade Locks
Bonneville
COLUMBIA
RIVER
Multnomah Falls
NORTH FORK RES.
WILLAMETTE BASE LINE
HOOD RIVER
BULL RUN RES. NO. 1
Bull Run Lake
BULL RUN RES. NO. 2
Roslyn Lake
Little Sandy River
Sandy
Brightwood
Welches
Zig Zag
Rhododendron
Zig Zag River
Government Camp
MOUNT HOOD
T 2½ S
CLACKAMAS
WASCO
R. 8½ E.
ASS 1 LANDS
ASS 2 LANDS
ASS 3 LANDS
SIDENTIAL - INDUSTRIAL LANDS
ASS 6 LANDS
MAP II-22
SANDY SUBBASIN
WILLAMETTE BASIN, OREGON
IRRIGABILITY LAND CLASSIFICATION
1965
SCALE IN MILES
2

Acreage Summary

Table II-18 lists acreages by land classes and subclasses -- both irrigated and dry, and cleared and uncleared -- for the Upper, Middle, and Lower Subareas of Willamette Basin. It also lists acreages of land inside city limits, in suburban residential or industrial use, and lands mapped as nonarable class 6. Tables II-19, -20, and -21 show the same acreage breakdown for each of the 11 subbasins.

In summary there are 1,488,130 acres of potentially irrigable land in Willamette Basin. In addition, there are 243,660 acres already under irrigation and 331,490 acres in cities or in suburban residential or industrial use. The remaining 5,645,720 nonirrigable acres in the Willamette Basin consist mostly of timbered or cutover mountainous lands.

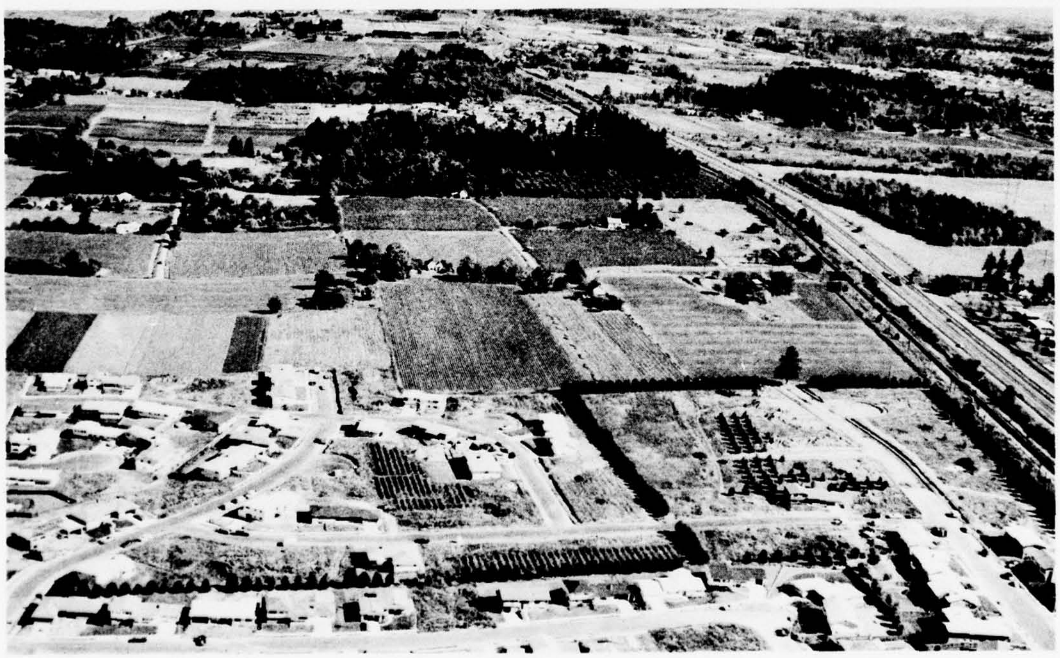


Photo II-9. Suburban encroachment on agricultural lands northeast of Portland near the Banfield Freeway. (Oregon State Highway Department Photo)

Table II-18

Acreage Summary of Irrigability Land Classes and Subclasses, Willamette Basin, 1965

Land Class and Subclass	Total Willamette Basin Irrigated	Total Willamette Basin Potentially Irrigable Total	Total Willamette Basin Uncleared	Total Willamette Basin Cleared	Upper Willamette Total Irrigated	Upper Willamette Potentially Irrigable Total	Upper Willamette Uncleared	Upper Willamette Cleared	Middle Willamette Total Irrigated	Middle Willamette Potentially Irrigable Total	Middle Willamette Uncleared	Middle Willamette Cleared	Lower Willamette Total Irrigated	Lower Willamette Potentially Irrigable Total	Lower Willamette Uncleared	Lower Willamette Cleared
Class 1	104,930	318,440	22,570	295,870	16,940	34,100	3,270	30,830	71,650	187,650	11,440	176,210	16,340	96,690	7,860	88,830
2s-h	10,370	166,180	25,820	140,360	260	11,140	1,930	9,210	8,390	115,790	16,480	99,310	1,720	39,250	7,410	31,840
-v	17,640	11,170	2,200	8,970	3,420	2,210	370	1,840	13,460	7,140	1,550	5,590	760	1,820	280	1,540
-k	8,020	17,950	2,410	15,540	1,110	4,770	230	4,540	6,380	7,970	1,240	6,730	530	5,210	940	4,270
2t-g	1,240	16,610	1,640	14,970		20		20	660	5,420	500	4,920	580	11,170	1,140	10,030
2d-f	11,590	16,510	2,840	13,670	2,600	3,660	490	3,170	7,540	11,720	2,240	9,480	1,450	1,130	110	1,020
2sd-hw	7,350	50,340	2,780	47,560	1,120	9,310	510	8,800	5,850	38,430	1,910	36,520	380	2,600	360	2,240
-pw	22,680	169,310	5,870	163,440	830	14,020	490	13,530	16,470	126,850	3,660	123,190	5,380	28,440	1,720	26,720
-hwf	5,950	19,070	1,730	17,340	480	3,120	320	2,800	3,320	9,860	1,000	8,860	2,150	6,090	410	5,680
-vf	6,500	8,550	2,770	5,780	2,830	3,110	410	2,700	3,630	5,020	2,270	2,750	40	420	90	330
2st-hg	2,210	52,750	10,110	42,640		1,080	90	990	990	28,590	6,130	22,460	1,220	23,080	3,890	19,190
Class 2	93,550	528,440	58,170	470,270	12,650	52,440	4,840	47,600	66,690	356,790	36,980	319,810	14,210	119,210	16,350	102,860
3s-b	510	13,460	1,950	11,510	30	1,640	140	1,500	480	11,120	1,520	9,600		700	290	410
-v	1,930	1,050	340	710	340	360	120	240	1,590	690	220	470				
-k	2,900	9,430	2,720	6,710	1,260	2,780	930	1,850	1,340	3,330	1,030	2,300	300	3,320	760	2,560
3t-g	510	3,740	360	3,380					480	1,650	200	1,450	30	2,090	160	1,930
3sd-hw	16,440	281,810	8,750	273,060	1,350	39,010	1,380	37,630	12,100	226,100	4,920	221,180	2,990	16,700	2,450	14,250
-kw	5,560	4,220	360	3,860	10	120		120	5,550	4,100	360	3,740				
-hwf	11,860	73,070	12,870	60,200	590	12,420	5,300	7,120	8,050	49,250	6,800	42,450	3,220	11,400	770	10,630
-vf	2,390	2,700	1,770	930	580	1,360	860	500	1,810	1,340	910	430				
-kf	640	3,440	2,020	1,420	200	1,530	620	910	440	1,910	1,400	510				
3st-hg	1,790	139,160	24,180	114,980	100	11,580	4,070	7,510	870	93,040	14,660	78,380	820	34,540	5,450	29,090
-bg	650	109,170	23,530	85,640	60	14,000	3,410	10,590	480	86,410	18,470	67,940	110	8,760	1,650	7,110
Class 3	45,180	641,250	78,850	562,400	4,520	84,800	16,830	67,970	33,190	478,940	50,490	428,450	7,470	77,510	11,530	65,980
Total 1,2,3	243,660	1,488,130	159,590	1,328,540	34,110	171,340	24,940	146,400	171,530	1,023,380	98,910	924,470	38,020	293,410	35,740	257,670
City			143,200				26,030				40,960				76,210	
Res. & Ind.			188,290				35,170				53,750				99,370	
Class 6			5,645,720				2,221,050				2,179,280				1,245,390	
Grand Total			7,709,000				2,487,700				3,468,900				1,752,400	

Source: U.S. Bureau of Reclamation

Table II-19

Acreage Summary of Irrigability Land Classes and Subclasses, Upper Willamette Subarea, 1965

Land Class and Subclass	Subbasin 1 Coast Fork				Subbasin 2 Middle Fork			
	Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable		
			Uncleared	Cleared			Uncleared	Cleared
Class 1	1,290	2,680	30	2,650	1,050	2,210	340	1,870
2s-h	80	3,250	300	2,950	20	1,180	220	960
-v	190	300	20	280	640	690	190	500
-k	150	1,670	60	1,610	110	1,300	120	1,180
2t-g								
2d-f	510	720	60	660	40	80	10	70
2sd-hw	200	2,200	180	2,020	20	1,040	10	1,030
-pw	10	390		390		560	20	540
-hwf	70	540	30	510				
-vf	230	480	90	390		20		20
2st-hg		790	90	700		70		70
Class 2	1,440	10,340	830	9,510	830	4,940	570	4,370
3s-b		380	20	360	30	360	110	250
-v		20		20	30	140	30	110
-k	110	290	20	270	120	710	420	290
3t-g								
3sd-hw	410	8,920	200	8,720		1,410	50	1,360
-kw		20		20				
-hwf	110	2,220	980	1,240		250	40	210
-vf		60	20	40	30	280	210	70
-kf	70	360	90	270		200	180	20
3st-hg	30	3,180	1,670	1,510		740	280	460
-bg	10	6,380	2,340	4,040		630	130	500
Class 3	740	21,830	5,340	16,490	210	4,720	1,450	3,270
Total 1,2,3	3,470	34,850	6,200	28,650	2,090	11,870	2,360	9,510
City			1,030				1,220	
Res. & Ind.			8,880				1,950	
Class 6			377,170				849,270	
Grand Total			425,400				866,400	

Land Class and Subclass	Subbasin 3 McKenzie				Subbasin 4 Long Tom			
	Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable		
			Uncleared	Cleared			Uncleared	Cleared
Class 1	3,460	3,930	180	3,750	11,140	25,280	2,720	22,560
2s-h	80	1,200	400	800	80	5,510	1,010	4,500
-v	1,000	480	10	470	1,590	740	150	590
-k	220	300	30	270	630	1,500	20	1,480
2t-g						20		20
2d-f	630	670	150	520	1,420	2,190	270	1,920
2sd-hw	430	1,760	110	1,650	470	4,310	210	4,100
-pw	20	280		280	800	12,790	470	12,320
-hwf	200	460	110	350	210	2,120	180	1,940
-vf	1,070	730	100	630	1,530	1,880	220	1,660
2st-hg		60		60		160		160
Class 2	3,650	5,940	910	5,030	6,730	31,220	2,530	28,690
3s-b						900	10	890
-v	110	80	20	60	200	120	70	50
-k	250	390	210	180	780	1,390	280	1,110
3t-g								
3sd-hw	30	1,330	170	1,160	910	27,350	960	26,390
-kw	10	100		100				
-hwf	40	200	20	180	440	9,750	4,260	5,490
-vf	200	570	350	220	350	450	280	170
-kf	70	400	130	270	60	570	220	350
3st-hg		560	170	390	70	7,100	1,950	5,150
-bg		470	60	410	50	6,520	880	5,640
Class 3	710	4,100	1,130	2,970	2,860	54,150	8,910	45,240
Total 1,2,3	7,820	13,970	2,220	11,750	20,730	110,[illegible]50	14,160	96,490
City			2,100				21,680	
Res. & Ind.			4,490				19,850	
Class 6			830,720				163,890	
Grand Total			859,100				336,800	

Land Class and Subclass	Upper Willamette Total			
	Irrigated	Potentially Irrigable		
			Uncleared	Cleared
Class 1	16,940	34,100	3,270	30,830
2s-h	260	11,140	1,930	9,210
-v	3,420	2,210	370	1,840
-k	1,110	4,770	230	4,540
2t-g		20		20
2d-f	2,600	3,660	490	3,170
2sd-hw	1,120	9,310	510	8,800
-pw	830	14,020	490	13,530
-hwf	480	3,120	320	2,800
-vf	2,830	3,110	410	2,700
2st-hg		1,080	90	990
Class 2	12,650	52,440	4,840	47,600
3s-b	30	1,640	140	1,500
-v	340	360	120	240
-k	1,260	2,780	930	1,850
3t-g				
3sd-hw	1,350	39,010	1,380	37,630
-kw	10	120		120
-hwf	590	12,420	5,300	7,120
-vf	580	1,360	860	500
-kf	200	1,530	620	910
3st-hg	100	11,580	4,070	7,510
-bg	60	14,000	3,410	10,590
Class 3	4,520	84,800	16,830	67,970
Total 1,2,3	34,110	171,340	24,940	146,400
City			26,030	
Res. & Ind.			35,170	
Class 6			2,221,050	
Grand Total			2,487,700	

Source: U.S. Bureau of Reclamation

Table II-20

Acreage Summary of Irrigability Land Classes and Subclasses, Middle Willamette Subarea, 1965

Land Class and Subclass	Subbasin 5 Santiam				Subbasin 6 Coast Range				Subbasin 7 Pudding				Middle Willamette Total			
	Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable		
			Uncleared	Cleared			Uncleared	Cleared			Uncleared	Cleared			Uncleared	Cleared
Class 1	14,850	31,640	1,610	30,030	22,640	83,460	3,250	80,210	34,160	72,550	6,580	65,970	71,650	187,650	11,440	176,210
2s-h	5,590	30,050	5,200	24,850	1,450	33,840	1,950	31,890	1,350	51,900	9,330	42,570	8,390	115,790	16,480	99,310
-v	8,180	3,590	760	2,830	3,060	2,390	570	1,820	2,220	1,160	220	940	13,460	7,140	1,550	5,590
-k	3,760	3,250	610	2,640	420	3,040	370	2,670	2,200	1,680	260	1,420	6,380	7,970	1,240	6,730
2t-g	90	60		60	220	3,320	210	3,110	350	2,040	290	1,750	660	5,420	500	4,920
2d-f	2,510	2,000	740	1,260	3,130	7,030	1,320	5,710	1,900	2,690	180	2,510	7,540	11,720	2,240	9,480
2sd-hw	1,990	10,030	860	9,170	1,770	18,210	420	17,790	2,090	10,190	630	9,560	5,850	38,430	1,910	36,520
-pw	2,570	37,310	320	36,990	3,060	39,290	830	38,460	10,840	50,250	2,510	47,740	16,470	126,850	3,660	123,190
-hwf	1,030	3,140	490	2,650	1,100	3,620	320	3,300	1,190	3,100	190	2,910	3,320	9,860	1,000	8,860
-vf	1,850	1,730	850	880	830	730	410	320	950	2,560	1,010	1,550	3,630	5,020	2,270	2,750
2st-hg	500	3,420	1,630	1,790	410	17,840	1,800	16,040	80	7,330	2,700	4,630	990	28,590	6,130	22,460
Class 2	28,070	94,580	11,460	83,120	15,450	129,310	8,200	121,110	23,170	132,900	17,320	115,580	66,690	356,790	36,980	319,810
3s-b	150	4,270	320	3,950	150	2,010	270	1,740	180	4,840	930	3,910	480	11,120	1,520	9,600
-v	760	140	20	120		70	60	10	830	480	140	340	1,590	690	220	470
-k	970	2,130	670	1,460	140	740	290	450	230	460	70	390	1,340	3,330	1,030	2,300
3t-g		100		100	60	680	80	600	420	870	120	750	480	1,650	200	1,450
3sd-hw	4,420	135,900	2,500	133,400	2,330	60,120	990	59,130	5,350	30,080	1,430	28,650	12,100	226,100	4,920	221,180
-kw	1,070	820	70	750					4,480	3,280	290	2,990	5,550	4,100	360	3,740
-hwf	2,370	15,210	2,490	12,720	2,630	22,330	2,640	19,690	3,050	11,710	1,670	10,040	8,050	49,250	6,800	42,450
-vf	1,560	660	470	190		90		90	250	590	440	150	1,810	1,340	910	430
-kf	400	1,560	1,250	310	40	130	20	110		220	130	90	440	1,910	1,400	510
3st-hg	130	11,780	3,560	8,220	210	43,570	6,470	37,100	530	37,690	4,630	33,060	870	93,040	14,660	78,380
-bg	60	9,400	1,660	7,740	320	60,110	11,170	48,940	100	16,900	5,640	11,260	480	86,410	18,470	67,940
Class 3	11,890	181,970	13,010	168,960	5,880	189,850	21,990	167,860	15,420	107,120	15,490	91,630	33,190	478,940	50,490	428,450
Total 1,2,3	54,810	308,190	26,080	282,110	43,970	402,620	33,440	369,180	72,750	312,570	39,390	273,180	171,530	1,023,380	98,910	924,470
City			9,440				15,080				16.440				40,960	
Res. & Ind.			10,750				25,800				17,200				53,750	
Class 6			1,178,410				660,730				340,140				2,179,280	
Grand Total			1,561,600				1,148,200				759,100				3,468,900	

Source: U.S. Bureau of Reclamation

Table II-21

Acreage Summary of Irrigability Land Classes and Subclasses, Lower Willamette Subarea, 1965

Land Class and Subclass	Subbasin 8 Tualatin				Subbasin 9 Clackamas				Subbasin 10 Columbia				Subbasin 11 Sandy				Lower Willamette Total			
	Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable			Irrigated	Potentially Irrigable		
			Uncleared	Cleared			Uncleared	Cleared			Uncleared	Cleared			Uncleared	Cleared			Uncleared	Cleared
Class 1	7,830	48,310	3,490	44,820	3,370	26,770	3,180	23,590	3,450	10,370	560	9,810	1,690	11,240	630	10,610	16,340	96,690	7,860	88,830
2s-h	870	12,590	1,540	11,050	810	25,500	5,760	19,740	40	1,100	110	990		60		60	1,720	39,250	7,410	31,840
-v					40	640	60	580	710	1,100	220	880	10	80		80	760	1,820	280	1,540
-k	50	580	70	510	220	4,090	870	3,220	230	230		230	30	310		310	530	5,210	940	4,270
2t-g	50	1,370	160	1,210	270	5,270	540	4,730	190	2,260	80	2,180	70	2,270	360	1,910	580	11,170	1,140	10,030
2d-f	850	840	40	800	600	270	60	210						20	10	10	1,450	1,130	110	1,020
2sd-hw	360	2,360	360	2,000	20	220		220		20		20					380	2,600	360	2,240
-pw	1,830	18,010	1,570	16,440	290	1,980	130	1,850	3,260	8,260	20	8,240		190		190	5,380	28,440	1,720	26,720
-hwf	2,090	5,770	320	5,450	60	320	90	230									2,150	6,090	410	5,680
-vf					40	420	90	330									40	420	90	330
2st-hg	720	15,140	2,020	13,120	190	5,110	1,720	3,390	310	2,770	150	2,620	—	60	—	60	1,220	23,080	3,890	19,190
Class 2	6,820	56,660	6,080	50,580	2,540	43,820	9,320	34,500	4,740	15,740	580	15,160	110	2,990	370	2,620	14,210	119,210	16,350	102,860
3s-b						630	290	340		70		70						700	290	410
-v																				
-k		30	30			370	60	310	280	1,750	10	1,740	20	1,170	660	510	300	3,320	760	2,560
3t-g	10					1,020	140	880		510	10	500	20	560	10	550	30	2,090	160	1,930
3sd-hw	510	7,620	1,010	6,610	280	5,240	1,340	3,900	2,200	3,800	100	3,700		40		40	2,990	16,700	2,450	14,250
-kw																				
-hwf	3,090	10,800	730	10,070	50	470	40	430	80	130		130					3,220	11,400	770	10,630
-vf																				
-kf																				
3st-hg	810	29,910	4,520	25,390		3,510	910	2,600	10	1,120	20	1,100					820	34,540	5,450	29,090
-bg	20	6,340	910	5,430	90	2,140	730	1,410	—	100	—	100	—	180	10	170	110	8,760	1,650	7,110
Class 3	4,440	54,700	7,200	47,500	420	13,380	3,510	9,870	2,570	7,480	140	7,340	40	1,950	680	1,270	7,470	77,510	11,530	65,980
Total 1,2,3	19,090	159,670	16,770	142,900	6,330	83,970	16,010	67,960	10,760	33,590	1,280	32,310	1,840	16,180	1,680	14,500	38,020	293,410	35,740	257,670
City			14,110				2,960				58,480				660				76,210	
Res. & Ind.			32,170				7,400				55,150				4,650				99,370	
Class 6			230,060				548,340				117,820				349,170				1,245,390	
Grand Total			455,100				649,000				275,800				372,500				1,752,400	

Source: U.S. Bureau of Reclamation

PROBLEMS OF IRRIGATION DEVELOPMENT

Problems which tend to limit irrigation development are largely the outgrowth of limitations imposed by the physical and economic environment; conflects in land use; and social institutional, and legal restraints. These limitations and restraints affect production costs, create inconveniences and uncertainties to the farmer, and affect cropping patterns and yields. Most of these problems can be solved. The solution for part of them will require the organization and construction of physical works and the expenditure of money. Some may be solved through educational programs, but others can be alleviated only through institutional, social, and legal changes.

WATER SUPPLY

Problems have arisen due to the areal and seasonal distribution of the water supply for irrigation. About 10 percent of the presently irrigated land has water shortages annually. The existence of more than 500,000 acres with water rights as compared to about 244,000 acres presently irrigated indicates that if more water right land were irrigated, shortages in some areas would be even more widespread.

A major portion of these water-short lands are in operating units which do not have ready access to streams with adequate flow. In many cases, they must rely for their water supply on the lower elevation tributaries, or streams which originate in the Coast Range. Scarcity of ground-water storage in the drainage areas of these streams results in low flows during the latter part of the irrigation season.

There have also been water supply porblems in a few local areas where irrigation water is obtained from wells. Some ground-water areas are having difficulty sustaining yields. This may be due, in part, to the increasing number of wells penetrating the aquifer and, in part, to inadequate construction of wells.

These factors have not only caused problems in some areas of present irrigation development, but also have had a deterrent effect on irrigation expansion, particularly indivual development. However, from the standpoint of the entire basin, water supply is not critical on an annual basis. Existing supplies -- surface water, ground water, and storage -- are available in sufficient quantities to provide a full irrigation water supply to many hundreds of thousands of additional acres. Therefore, most of the present water supply problems probably can be solved through organization and construction of community-type irrigation distribution systems and by providing storage on additional tributary streams.

FLOODING AND DRAINAGE

An estimated 720,000 acres of irrigable land in the Willamette Basin have a wetness problem, caused either by an internal drainage characteristic of the soils, inadequate outlets, or by overflow of floodwaters. Crop adaptability and yield are limited on these lands. Improvement of natural channels and construction of major outlets for drainage and flood protection are often prerequisites for development of these lands for irrigation. Nearly 91,000 acres of these lands are presently irrigated.

Frequent flooding creates a problem on about 162,000 irrigable acres, which lie adjacent to streams; of this total, 39,000 acres are presently irrigated. Some of this land has not been developed or is being maintained in permanent cover because of this flood threat. Those farmers who irrigate and intensively farm these lands select crops with planting and harvesting dates that normally do not coincide with the flood season. Establishment of a good cover crop in the fall is a necessity to protect against scour and erosion of topsoil. Irrigation and farming equipment must be moved to high ground during the winter flood season. Failure to take these precautions results in serious losses to the irrigator. Even with the best of planning and management, infrequent floods of large magnitude cause damage to improvements, equipment, crops, and the land in overflow areas.

Photo II-10. Annual flooding creates problems on much of the irrigable lands adjacent to streams, such as on this land near Harrisburg.
(U.S. Department of Agriculture Photo)

Storage reservoirs have reduced the risk of flooding along the main stem of the Willamette and some of the major tributaries. Channel improvement has reduced the risk along some of the smaller tributaries. However, there are several thousand acres not protected by flood control works, and flooding is still a recurrent problem.

Drainage restrictions within the soil profile and/or lack of adequate outlets creates an excessive wetness problem on nearly 668,000 irrigable acres, of which about 70,000 acres are presently irrigated. Drainage can improve production on these soils; however, in many cases lack of adequate outlets hinders the installation of individual farm drainage systems. It also causes ponding of storm water in many areas.

Drainage deficiency varies considerably throughout the basin. Irrigation of the poorer drained soils is quite restricted. Crops are generally limited to those tolerant of poor drainage conditions. In other areas where drainage restrictions are less serious, some crops for the local processing industry are being grown successfully under irrigation. Research is presently underway on some of the poorer drained soils to determine the effect of drainage on crop suitability and yield under irrigation, and early results are encouraging.

Drainage improvements which at least partially alleviate the wetness problem have been installed on much of this acreage. However, before any large-scale irrigation expansion can take place in these areas, drain systems should be constructed that will provide outlets for individual farms and remove excess surface water. Throughout much of the basin, this can be done only through cooperative effort.

WATER MANAGEMENT

Problems in water management are primarily related to either the design or the operation of sprinkler systems. Rates of application, to prevent excessive erosion and water loss from surface runoff, are generally satisfactory. Improper timing of irrigation, even with adequately designed systems and a reliable water supply is the biggest contributor to the inefficient application and use of water. Field observations and tests indicate that the most desirable management practices are followed on only about 20 percent of the irrigated area.

Continued educational programs, improved irrigation equipment, new techniques, and the experience of irrigators are contributing to improved irrigation water use on the farm. However, there is still opportunity for greatly improved efficiency on a sizable portion of the presently irrigated lands.

ECONOMIC AND OTHER PROBLEMS

There are some additional problems or factors which have influenced the rate of irrigation development in the basin. They are related to economics and the social, legal, political, and institutional environment or some combination of these.

From a purely economic standpoint, agricultural production is governed by the law of supply and demand; however, the interplay of economic forces is altered by the social, political, and legal environment. Irrigation as a factor in the supply process increases production on a per-acre basis, provides numerous alternatives to produce crops not possible otherwise and improves the quality of some crops.

One problem the individual farmer faces in determining the economic feasibility of irrigation is related to the competitive structure of the markets he may desire to supply. The acreage of some irrigated crops, principally vegetables for processing, is controlled by contracts between the growers and the processors. Other crops such as those used for beef production are unrestricted at the farm level except for the price for beef cattle determined in a broad national market.

In the Willamette Basin there are large acreages of land that are nearly equally well adapted to the production of several different kinds of crops. For example, much of the land can be used for either irrigated pasture or irrigated sweet corn. The acreage of both crops is increasing at the present time.

Another problem relates to water rights which, in much of the basin, have not been adjudicated. This lack of adjudication has created uncertainties as to priorities for the irrigators and may have hindered expansion of irrigation, both on individual farms and on proposed community projects. Adjudication is needed to establish a picture of present conditions and as a guide for future development.

Urban and industrial expansion has taken over some of the most productive irrigated land in areas adjacent to several cities in the valley. For example, an operating community project near Springfield was abandoned because of urban expansion. Irrigators in areas adjacent to the expanding urban centers are currently adversely affected because of exceptionally high taxes brought about by increased land values. Also, rural nonfarm tracts are interspersed in increasing numbers throughout the irrigated and potentially irrigable areas. They impose distribution system problems in existing community projects, and make the planning and implementation of potential projects much more difficult.

STATUS OF PROPOSED PROJECTS

In the Willamette Basin, Federal agencies are actively engaged in the investigation of multipurpose projects which include irrigation. The Bureau of Reclamation and the Soil Conservation Service have the primary responsibility for irrigation planning, and each agency has a number of studies in various stages of investigation.

Most of the concerted interest in large-scale irrigation project development is in the northern half of the basin, particularly the northwest quadrant. At present, local sponsors are backing four Federal projects totaling nearly 70,000 acres in Polk, Yamhill, and Washington Counties. In addition, most of the current studies to determine the feasibility of large-scale project developments are being conducted in the northern half.

Interest in project irrigation in the southern part of the basin has been fairly high in the aggregate, but areas of concerted interest are less extensive. However, the recent formation of the Upper Willamette Resource Conservation and Development Project may provide a nucleus for accelerated irrigation development in that area.

Interest in project irrigation development has increased rather rapidly in recent years. As a case in point, owners of some 5,000 acres in the Monmouth-Dallas area indicated interest in 1955; this increased to 12,000 acres by 1962, and to 17,200 acres by 1964. Based on this trend in interest, project works have been planned with deferred capacity so that eventually 28,000 acres can be irrigated in this area. Interest in irrigation projects has also developed in a similar manner in several other areas.

PUBLIC LAW 566 PROGRAM

Public Law 566, which provides for the development of small watersheds, is administered by the Soil Conservation Service, U.S. Department of Agriculture. This law provides for the development of drainage areas which do not exceed 250,000 acres in extent and limits the size of reservoirs to a maximum of 25,000 acre-feet.

Work plans have been completed and construction has been authorized for the Beaver Creek and Lower Amazon-Flat Creek watershed projects. The Beaver Creek Project, near Stayton in Marion County, will irrigate some 3,500 acres. The Lower Amazon-Flat Creek Project will irrigate about 3,000 acres in Lane and Benton Counties, near Junction City. By June 1968, 15 other watershed projects with irrigation as a possible function had submitted applications for planning assistance. In these watersheds, there are 36,000 acres presently irrigated, and about 282,000 acres which are potentially irrigable. One of these, where planning is well advanced, is the McKay-Rock Creek Project in the Tualatin Subbasin. Local sponsors are hopeful for early development of this project.

RECLAMATION PROGRAM

The Bureau of Reclamation has completed feasibility studies on the Tualatin Project and the Monmouth-Dallas and Red Prairie Divisions of the Willamette River Project. About 60,000 acres of irrigable lands are involved in the three projects. Feasibility studies are currently underway for Carlton and Molalla Divisions, in the Coast Range and Pudding Subbasins, respectively. Potentially irrigable lands in these two divisions total about 200,000 acres.

As a part of its continuing responsibility for marketing Federally stored irrigation water, the Bureau of Reclamation is considering plans to irrigate lands using storage from existing Corps of Engineers reservoirs or from those planned for future years. Water from this source will no doubt be used at an accelerating rate as interest increases.

FUTURE DEMANDS

[illegible]

The Willamette Basin is still in the formative stages of irrigation development. Only about 15 percent of the irrigable acreage is presently irrigated. It is not likely that all the basin's irrigable acreage will be irrigated, for a variety of reasons. However, it is important from the standpoint of efficient resource use that lands ideally suited for this purpose be developed, because irrigation will contribute to the achievement of general public goals.

Following are five objectives for irrigation development in the Willamette Basin. Some, inherently, are wider in application than others. These objectives are responsive to current and future needs for irrigation development in the basin.

G O A L S   A N D   O B J E C T I V E S

1. Increase production of food and fiber to help meet the needs of the expanding population.

The population of Oregon, the Nation, and the world is expected to double in the next 35 to 40 years, and the demand for food and other agricultural products will increase accordingly. The expansion of irrigation, along with the application of other constantly improving production technologies, will enable the Willamette Basin to fulfill at least its part in satisfying this demand.

The Willamette Basin is in an advantageous position to supply other areas with agricultural products. It is favorably situated geographically to supply the expanding markets in the Pacific Northwest, and the raw and processed agricultural products can move through the Port of Portland to markets on the West Coast and throughout the world. Thus, with an extensive area of irrigable lands, an abundant water supply, and a favorable climate, the Willamette Basin is ideally equipped for further development of irrigated agriculture.

The advance of irrigation in the Willamette Basin will not be hindered by the need to start from a base of raw, uncleared land with a sparse population and meager facilities. The basin's irrigable lands are already developed in the sense that they have an adequate farm population who have cleared and cultivated the bulk of the land, developed adequate school and road systems, and have all the modern utilities available to them.

There are many crops on which irrigation expansion can be based. For example, the basin's food processing industry is largely dependent on high-value vegetable and fruit crops grown under irrigation. Continued growth of this industry will necessitate an expansion of the supporting irrigated acreage. Presently, about half of the irrigated acreage is devoted to the production of forage and feed crops. The livestock industry has increased considerably during recent years, and there is room for further expansion of this industry through irrigation. The basin now imports a substantial portion of its beef and other meat products as well as an increasing amount of dairy products.

2. Support the continued growth of the basin's economy.

It is possible to grow many crops in the basin without irrigation; however, these crops must be capable of maturing with limited summer rainfall. Yields and quality of many nonirrigated crops vary greatly from year to year in accordance with the seasonal precipitation. With irrigation there is the assurance that predictable yields of specified quality can be obtained.

Irrigation also provides the opportunity to grow a wider range of crops. Diversity in cropping possibilities will permit the basin's agricultural industry to shift production to meet changing market demands. This flexibility, together with less variability in yield and quality of crops, leads to a higher and more stable agricultural economy.

Irrigation provides the means for intensifying production on the individual farm. It enables the farmer to expand the volume of his business to meet the rising costs of land ownership, labor, and machinery. Irrigation also makes possible the use of other improved production techniques, resulting in increased yields and returns to the farmer for his investment and labor.

Supported by irrigation expansion, a growing agricultural economy would have a significant effect on the basin's overall economy. Additional job opportunities would be created in processing and marketing irrigated crops. Increased amounts of supplies, equipment, and services required by the farmer would create a larger volume of business for service industries. Nearly all sectors of the basin's economy would be stimulated, and benefits would be realized in other sections of the Nation in the manufacture, transportation, and handling of goods.

Photo III-1. Additional job opportunities are created in the processing of irrigated crops. Green bean inspection line at a Salem cannery.
(California Packing Corporation Photo)

3. Assure that irrigation can be developed when desired and needed.

The ultimate irrigated acreage needs to be established, and sufficient water allocated for its future development. Appropriate legal steps should be taken to assure that an adequate irrigation water supply is available at the proper time and location. Land ideally located and suited to irrigation in the Willamette Basin is limited. Urban encroachment and other nonfarm land uses are removing a portion of the better land from agricultural production each year. Use of prime agricultural land for other purposes, where less productive land would serve as well, represents a loss in economic opportunity. Land use planning and zoning would help guide urban and industrial development toward those lands unsuited, or less suitable, for irrigation. Relative to the concept of "flood plain zoning," much of the better irrigable land is located on the flood plain and, in most cases, its use for agricultural purposes is not seriously impaired by minor floods.

Another aspect related to future irrigation development has to do with the planning and construction of facilities. Major structures, such as dams, should be planned for optimum use of the resource. Irrigation distribution systems should be designed so that they can be readily expanded at a minimum of cost. The construction of facilities in a manner which would unduly restrict or prevent full development should be discouraged.

4. Develop irrigation to complement other functions and blend harmoniously with the environment.

With multiple-purpose planning, irrigation developments can and should make maximum contribution to other water resource functions. For example, as an alternate to other types of treatment, warm industrial waste water and water carrying organic material can often be used for irrigation if proper safeguards are provided. Wildlife refuges can be incorporated into irrigation and drainage developments and their usefulness can be enhanced by properly controlling water supplies. Water quality and fishery habitats can be improved when stream channels are used to deliver stored water to irrigable lands. Irrigation developments can contribute substantially to recreation pursuits where proper facilities are provided. Other opportunities are available whereby irrigation development can contribute to more efficient use of our resources.

In the past, the aesthetic appearance of irrigation developments has not been a paramount consideration. Recently, however, designs for appearance have been incorporated into Federal construction programs in accordance with the President's directive whereby Federal projects of the future will have structures

which are more aesthetically pleasing and in harmony with the landscape. This objective should also be encouraged for non-Federal projects.

Irrigation facilities should be designed to provide a safe environment. Since accidents occasionally happen at irrigation structures, it is imperative that safety precautions be taken to minimize hazards and provide maximum safety for the public.

5. Continue research and education programs in irrigation technology.

Continuing research will be necessary to develop adaptable crops under irrigation. Particular attention should also be devoted to developing other crops to meet changing market demands. Research into soil, water, and crop management is also necessary to achieve more efficient water application, and to improve methods of drainage of irrigated fields. Oregon State University and the Agricultural Research Service presently provide research in these areas; these programs should be expanded. Studies by industry will also continue to be important in improving the efficiency and workability of various types of irrigation equipment.

As water is brought to the unirrigated land in the Willamette Valley, farmers must learn how to select and operate irrigation equipment, how to irrigate different crops on different soils, and at the same time acquire entirely new management techniques essential to intensive irrigation farming. It is therefore desirable that educational programs of the Extension Service, Soil and Water Conservation Districts, and the Soil Conservation Service be continued and intensified. Power companies, equipment manufacturers and distributors, financial institutions, processing plants, and other private agencies can also contribute substantially toward this educational program.

IRRIGATION PROJECTIONS

From 1929 to 1965, the irrigated acreage has grown from about 5,000 to 244,000 acres. Conditions which brought about irrigation development in the past are expected to continue to influence additional development in the future. This section presents projections of acres of land to be irrigated, water requirements, and anticipated production for 1980, 2000, and 2020. In making these projections such factors as urban expansion, interest in community irrigation developments, availability of irrigable land, advancement of agricultural technology, and demand for food and fiber were considered.

Projections for all agricultural land use and production are contained in Appendix C - Economic Base. The Irrigation Appendix is concerned with projections of irrigated land and production. Some differences are apparent between the two appendices, particularly in long-range projections. Each appendix, however, presents a reasonable picture based upon justifiable assumptions and methodology.

They are similar in that both appendices assume that Willamette Basin will meet its proportionate share of the food and fiber needs projected for the U.S. and Oregon through year 2020. They are also in complete agreement on population projections for the basin.

They diverge on two basic assumptions; the extent of urban encroachment on agricultural land, and the increase in yields per acre of the crops grown in the area, particularly vegetables. In spite of these differences, there is very little variation in the total land use and yields projected for year 1980. However, by year 2020, the land use picture that develops in each appendix is quite different.

PROJECTIONS OF IRRIGATED LAND

Land Resource

As shown in Part II - Present Status, there are about 1,732,000 acres physically suited for irrigation, based on classification of the land. Of this total, 244,000 acres are presently irrigated and 1,488,000 additional acres remain for possible development in the future. However, residential, industrial, and recreational uses are quite successful in bidding land away from agriculture.

Projections of irrigable acreage must reflect an expanding population and a continuing loss of irrigable land to nonagricultural uses. The per-acre population density in urban areas for 1965 was determined to be about 3 persons per acre in the Upper and Middle Subareas, and 4.5 persons per acre in the Lower Subarea. Since the typical density for mature suburban development is about six persons per acre (Oregon State Department of Commerce, Division of Planning and Development, Policy for Urbanization) it is assumed that population density in the basin will increase toward this level. Density increases of 0.5 person per acre for each time period were applied to the projected increase in

population. In this way, beginning from a base of 332,000 acres in 1965, urban and built-up area was estimated to increase to 434,000 by 1980; 569,000 by 2000; and 783,000 acres by 2020. (By comparison, the Economic Base Appendix, which uses an earlier base period and a nearly constant level of population density, shows higher cumulative totals.) Eighty percent of this expansion is estimated to take place on irrigable land, nearly all of which is in agricultural use at present. As shown in Table III-1, the irrigable acreage (including irrigated land) would be reduced to 1,650,000 acres, 1,542,000 acres, and 1,371,000 acres by 1980, 2000, and 2020 respectively.

Table III-1
Projections of Irrigable 1/ Acreage

Subbasin	1965 Irrigable Acreage	Remaining Irrigable 1980	Remaining Irrigable 2000	Remaining Irrigable 2020
	(thousands of acres)			
1 - Coast Fork	38	35	32	27
2 - Middle Fork	14	13	12	10
3 - McKenzie	22	20	17	14
4 - Long Tom	132	119	104	83
Upper Subarea	206	187	165	134
5 - Santiam	363	358	353	346
6 - Coast Range	447	436	425	413
7 - Pudding	385	376	368	357
Middle Subarea	1,195	1,170	1,146	1,116
8 - Tualatin	179	168	142	77
9 - Clackamas	90	88	74	32
10- Columbia	44	20	0	0
11- Sandy	18	17	15	12
Lower Subarea	331	293	231	121
Willamette Basin	1,732	1,650	1,542	1,371

1/ *Irrigable includes irrigated and potentially irrigable acreage.*

Irrigated Acreage

Present development has been based primarily on private initiative and capital. Future development will become increasingly dependent on existing and new storage and on development of distribution systems capable of delivering water to lands located at a distance from the source of supply; developments of this type are often planned and constructed

with Federal financing. One such development authorized in the Willamette Basin was obtained by the Tualatin Irrigation District in 1966. Other groups actively seeking authorization and Federal assistance for development are located in the McKay-Rock Creek area in Washington County, Monmouth-Dallas and Red Prairie Irrigation Districts in Polk County, and the Grand Prairie area in Linn County. People located in the North Yamhill, Molalla-Pudding, Luckiamute, and Marys River drainages and in other areas have also expressed an interest in community irrigation development.

Over 60 percent of the presently irrigated acreage has been developed since 1949. However, this does not fully reflect interest in irrigation development because local interests have actively engaged in securing Federal funds for planning community projects during this same period. Current activities by similar groups are expected to have an additional influence on the rate of future development. Therefore, projected irrigation development through 2000 is based on an extension of the historical trend of actual development during the period 1949-1965, plus those community projects that would likely be developed by that date. Development after 2000 is expected to occur at a reduced rate as potentially irrigable lands become scarce and more remote from water supplies. As shown in Table III-2 (and graphically on Figure III-1) it is expected that 430,000, 850,000, and 1,000,000 acres will be irrigated by 1980, 2000, and 2020, respectively. These projected acreages are considered adequate to provide the basin's proportionate share of food and fiber at each point in time. About 371,000 acres of potentially irrigable land will remain in 2020.

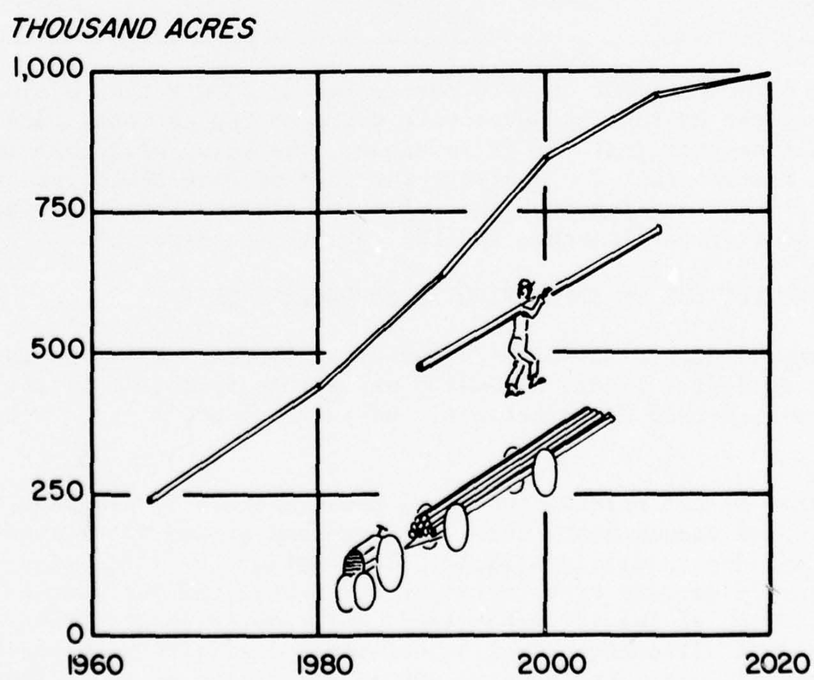


Figure III-1. Projected Growth of Irrigation

Table III-2
Projections of Irrigated Acreage

Subbasin	1965	1980	2000	2020
		(thousands of acres)		
1 - Coast Fork	3	8	16	20
2 - Middle Fork	2	3	5	7
3 - McKenzie	8	9	12	10
4 - Long Tom	21	30	47	63
Upper Subarea	34	50	80	100
5 - Santiam	55	83	192	232
6 - Coast Range	44	133	262	310
7 - Pudding	73	104	216	258
Middle Subarea	172	320	670	800
8 - Tualatin	19	43	74	68
9 - Clackamas	6	7	22	25
10- Columbia	11	8	0	0
11- Sandy	2	2	4	7
Lower Subarea	38	60	100	100
Willamette Basin	244	430	850	1,000

The rate of development could occur faster or slower than projected. If it is faster, the basin's proportionate share of the national food and fiber needs will be exceeded. If it is slower, the basin will fall short of its share. Factors that could affect the rate of development are the incentive for private development, the political climate for authorization of Federally constructed projects, and the rate of urbanization.

PROJECTIONS OF IRRIGATION WATER REQUIREMENTS

Projections of future water needs for irrigation are based on the projections of irrigated lands, estimated water requirements for several crop types, expected crop distributions, and judgment as to the source of supply.

As indicated by past irrigation development, future development can occur on an individual basis where surface- and ground-water supplies and storage are readily available. In general, the irrigation season water supply on many tributaries is fully utilized and overappropriated, and much of the irrigable lands adjacent to larger tributaries and the main Willamette River are presently irrigated. Consequently, much of the projected development of irrigation on an individual basis will of necessity occur in areas of abundant and economical ground-water supply. Future development of ground-water supplies would

not necessarily be limited to individual developments, since community-type developments could also occur in these areas. However, the following projections of ground water use do give some indication of future development by individuals because readily available surface supplies are limited.

Projections of future irrigation from ground-water sources were made by comparing maps of ground-water availability, Appendix B - Hydrology, with Maps II-1 through II-11 to indicate the acreage available for development in areas of abundant ground-water supply. The projected acreages and water requirements to be supplied from ground-water sources in each subbasin for years 1980, 2000, and 2020 are shown in Table III-3.

A large proportion of the remaining projected irrigated acreage would be developed by utilizing surplus natural flows and reservoir storage. Most of the easily accessible surface water supplies in the basin are now being utilized. Also, most future developments will be community developments utilizing distribution systems. In projecting future irrigation water needs from surface sources, it is assumed that distribution systems will become more efficient and losses will be less; this would be possible by lining earth canals and constructing closed pipe systems. The system losses are estimated to be 20 percent in 1980, 15 percent in 2000, and 10 percent in year 2020. The projected irrigation water requirements to be supplied from surface-water sources and the estimated return flows are shown in Table III-4.

Photo III-2. A closed pipe irrigation system under construction. Efficient systems such as this will reduce distribution losses in the future.
(U.S. Department of Agriculture Photo)

Table III-3

Projections of Irrigation Requirements from Ground-Water Sources

	1980			2000			2020		
Subbasin	Irrigated Acreage	Annual Pumping Requirement (acre-feet)	Depletions (acre-feet)	Irrigated Acreage	Annual Pumping Requirement (acre-feet)	Depletions (acre-feet)	Irrigated Acreage	Annual Pumping Requirement (acre-feet)	Depletions (acre-feet)
1 - Coast Fork	700	1,700	1,100	1,100	2,700	1,800	1,100	2,700	1,800
2 - Middle Fork	700	1,700	1,100	1,400	3,400	2,200	2,200	5,300	3,500
3 - McKenzie	4,200	10,200	6,700	6,000	14,500	9,500	5,000	12,100	7,900
4 - Long Tom	15,400	37,300	24,500	20,000	48,400	31,800	20,000	48,400	31,800
5 - Santiam	30,000	69,500	45,600	35,000	81,100	53,200	40,000	92,600	60,800
6 - Coast Range	20,000	46,300	30,400	25,000	57,900	38,000	25,000	57,900	38,000
7 - Pudding	42,400	98,200	64,400	88,500	204,900	134,400	109,200	252,900	165,900
8 - Tualatin	2,200	5,800	3,800	3,600	9,500	6,200	3,400	8,900	5,800
9 - Clackamas	2,300	6,000	3,900	6,000	15,800	10,400	8,300	21,800	14,300
10- Columbia	2,000	5,300	3,500	0	0	0	0	0	0
11- Sandy	1,100	2,900	1,900	2,400	6,300	4,100	3,800	10,000	6,600
Willamette Basin	121,000	284,900	186,900	189,000	444,500	291,600	218,000	512,600	336,400

Table III-4

Projections of Irrigation Requirements from Surface-Water Sources

Subbasin	1980			2000			2020		
	Irrigated Acreage	Diversion Requirement (acre-feet)	Return Flow (acre-feet)	Irrigated Acreage	Diversion Requirement (acre-feet)	Return Flow (acre-feet)	Irrigated Acreage	Diversion Requirement (acre-feet)	Return Flow (acre-feet)
1-Coast Fork	7,300	21,100	8,700	14,900	40,300	15,800	18,900	48,300	17,800
2-Middle Fork	2,300	6,600	2,800	3,600	9,700	3,800	4,800	12,300	4,500
3-McKenzie	4,800	13,800	5,700	6,000	16,200	6,400	5,000	12,800	4,700
4-Long Tom	14,600	42,100	17,500	27,000	73,100	28,600	43,000	109,900	40,400
5-Santiam	53,000	145,800	60,600	157,000	406,400	159,300	192,000	469,300	172,700
6-Coast Range	113,000	310,800	129,300	237,000	613,400	240,500	285,000	696,700	256,400
7-Pudding	61,600	169,500	70,500	127,500	330,000	129,400	148,800	363,700	133,900
8-Tualatin	40,800	127,500	53,000	70,400	207,100	81,200	64,600	179,500	66,000
9-Clackamas	4,700	14,700	6,100	16,000	47,100	18,400	16,700	46,300	17,100
10-Columbia	6,000	18,800	7,800	0	0	0	0	0	0
11-Sandy	900	2,800	1,200	1,600	4,700	1,800	3,200	8,900	3,300
Willamette Basin	309,000	873,500	363,200	661,000	1,748,000	685,200	782,000	1,947,700	716,800

IRRIGATION ECONOMY

A net increase of about 750,000 irrigated acres has been projected during the study period, from 244,000 in 1965 to 1,000,000 acres in 2020; the major portion of development is expected to occur by 2000. This growth will have a tremendous impact on the basin's economy. Some of the changes expected to occur due to this projected growth are discussed in this section.

FARM TYPES

The proportion of irrigated farms to total farms is expected to increase throughout the study period. By 2000, a majority of farms would be irrigated, and by 2020, nearly all farmers will be irrigating at least some of their lands.

As irrigation development continues, average farm size will probably increase for a period of time and then stabilize at some point in the future. Small part-time farms may be consolidated with full-time units, and large units may subdivide as irrigation is adopted and production becomes more intensive. Acreage limitations now imposed by certain Federal programs for irrigation development, unless amended, could be an important factor in the average size of irrigated farms in the future.

With increases in irrigated acreage and farm size, a greater percentage of farms will probably be "commercial" farms, with fewer part-time farms. A greater degree of specialization will probably occur as irrigation is adopted. Both the number and percentage of farms (relative to all farms) specializing in the production of vegetables, fruits, or livestock are expected to increase.

CROP YIELDS

The projections of irrigated crop yields reflect a composite of past trends, technological advances, and particularly an expected decline in the average quality of irrigated land. It is expected that the higher-quality lands would be irrigated first, and progressively lower-quality lands would be irrigated thereafter. A 2 percent annual increase in yields is expected to occur through year 2000; beyond 2000 a reduced rate of 1 percent per annum increase was applied. Particular crops were adjusted where evidence indicated yields would follow a different pattern. The projected yields for irrigated crops are presented in Table III-5.

There are some differences in projected yields between this appendix and the Economic Base Appendix. The most significant is in vegetables where the Economic Base Appendix projects from a base of 7.2 tons per acre in 1959-1961 to 9.0, 13.2, and 19.8 tons per acre in 1980, 2000, and 2020 respectively.

Table III-5
Projected Yields for Irrigated Crops

Crop	Unit	1964	1980	2000	2020
			(Units per acre)		
Pasture	A.U.M. 1/	12.1	15.1	20.6	24.7
Hay and Silage	Tons	2.67	3.38	4.64	5.57
Small Grains and Corn	Tons	1.66	2.11	2.89	3.47
Vegetables (beans & sweet corn)	Tons	5.56	5.49 2/	7.52	9.03
Fruit	Tons	2.38	3.15	4.11	4.57

1/ Animal unit equivalents per month

2/ Based on assumption conversion from pole to bush beans will be completed by 1980

Photo III-3. Irrigation and drainage research conducted by Oregon State University on the Jackson farm near Lebanon will help solve some of the problems associated with irrigation development.
(U.S. Bureau of Reclamation Photo)

IRRIGATED LAND USE

The major uses of irrigated land at the present time are for production of specialty crops (such as fruits, vegetables, and mint) and livestock feeds. Projected production of food and fiber (see Appendix C - Economic Base) was considered along with the projected per-acre yields for irrigated crops in determining future irrigated land use. As shown in Table III-6, the expanded irrigated acreage would be devoted primarily to the production of specialty crops and of feed crops to satisfy livestock requirements. Most Willamette Basin soils are suitable for the production of a diversity of crops; therefore, with an expanding market for higher-value crops, shifts in acreages from one crop to another can be accomplished readily as needed.

Table III-6
Irrigated Land Use - 1965, 1980, 2000, and 2020

Crop	1965 1/	1980	2000	2020
	(thousands of acres)			
Hay, Pasture and Silage	99	180	380	420
Small Grains and Corn	14	40	170	210
Specialty Crops 2/	104	170	220	270
Field Seed	6	20	40	50
Other	21	20	40	50
Total	244	430	850	1,000

1/ *Irrigated crop acreage determined for 1965 prorated on basis of irrigated land use reported in 1964 Census of Agriculture.*

2/ *Includes vegetables, fruit, potatoes, hops, mint, and sugar beet seed.*

LIVESTOCK

The production of livestock and livestock products is expected to become increasingly dependent on feed crops grown on irrigated land. Comparison of the projected feed production on irrigated land (Table III-7) with the projected production of livestock and livestock products (Table III-8) shows feed produced on irrigated lands will provide about 30 percent of the 1980 requirement and about 80 percent of the 2000 and 2020 requirements. These projections reflect increases in the efficiency of feed conversion.

Table III-7

Projected Feed Production on Irrigated Land

	1964 2/	1980	2000	2020
	(in thousands of animal-unit-equivalents 1/)			
Pasture	42	139	413	556
Hay	19	47	130	165
Feed Grains and Corn	5	25	147	219
Total	66	211	690	940

1/ *One animal unit is equal to 5,040 pounds of total digestible nutrients; this is generally recognized as the amount required to feed one beef cow for one year.*

2/ *Based on 1964 Census of Agriculture and 188,000 irrigated acres.*

Table III-8

Projected Production of Livestock and Products 1/

	1964 2/	1980	2000	2020
	(in thousands of animal-unit equivalents)			
Cattle and Calves 3/	265	370	473	652
Sheep and Lambs	74	84	110	148
Hogs	20	35	46	62
Poultry	52	89	114	156
Milk Cows	69	103	132	181
Total	480	681	875	1,199

1/ *Based on Appendix C - Economic Base*

2/ *Based on 1964 Census of Agriculture and 188,000 irrigated acres.*

3/ *Excluding milk cows*

VALUE OF PRODUCTION ON IRRIGATED LAND

The values of projected crops, livestock and livestock products, as shown in Table III-9, for the years 1980, 2000, and 2020 are estimated to be approximately $100, $250, and $370 million, respectively. The prices used in determining the values of specialty crops are derived from values used in Appendix C - Economic Base. Values for small grains, hay, and pasture do not appear in Table III-9. All irrigated production from these crops was found to be necessary to meet projected livestock needs. The revenue generated from these crops appears in the form of livestock or livestock products sales. The proportion of feed produced on irrigated land (see preceding section), applied to the values for all livestock and livestock products, represents the value of livestock and livestock products from irrigated land. The values projected for field seeds and other crops are based on the average value per acre of specialty crops and livestock and products combined.

Table III-9
Value of Crops and Livestock and Products Produced on Irrigated Land

Item	1964 1/	1980	2000	2020
		(Million dollars)		
Specialty Crops 2/	47.3	63.5	117.9	175.1
Field Seed and Other Crops	5.3	9.6	23.4	36.8
Livestock and Products	8.8	30.4	106.8	156.4
Total	61.4	103.5	248.1	368.3

1/ *Based on 1964 Census of Agriculture and 188,000 irrigated acres.*

2/ *Includes horticultural crops.*

MARKETS

Most of the products from irrigated lands in the basin are marketed locally for processing. A well-developed complex of processors is located conveniently to producers, which facilitates the marketing of agricultural products. It is expected that processing, transportation, and other facilities will expand to meet the growing demand for the marketing of agricultural products.

FUTURE IRRIGATION PROBLEMS

Many of the social, economic, institutional, and physical problems associated with irrigation are expected to continue with future development, their actual magnitude depending on the specific conditions in a local area. These problems are associated with water supply, flooding and drainage, water management, land use, and economics.

Irrigation is the largest consumptive use of water, but it is estimated that only about 8 percent of the basin's annual runoff will be used for irrigation by 2020; all other projected consumptive uses amount to less than 2 percent of the annual runoff. The total supplies of the basin are greatly in excess of the anticipated consumptive needs. However, the extreme variations in seasonal flows will make future irrigation more and more dependent upon storage and ground-water development. Projections for 2020 show that approximately three-fourths of the irrigation development will be from surface water (including storage) and the remaining one-fourth from ground-water supplies.

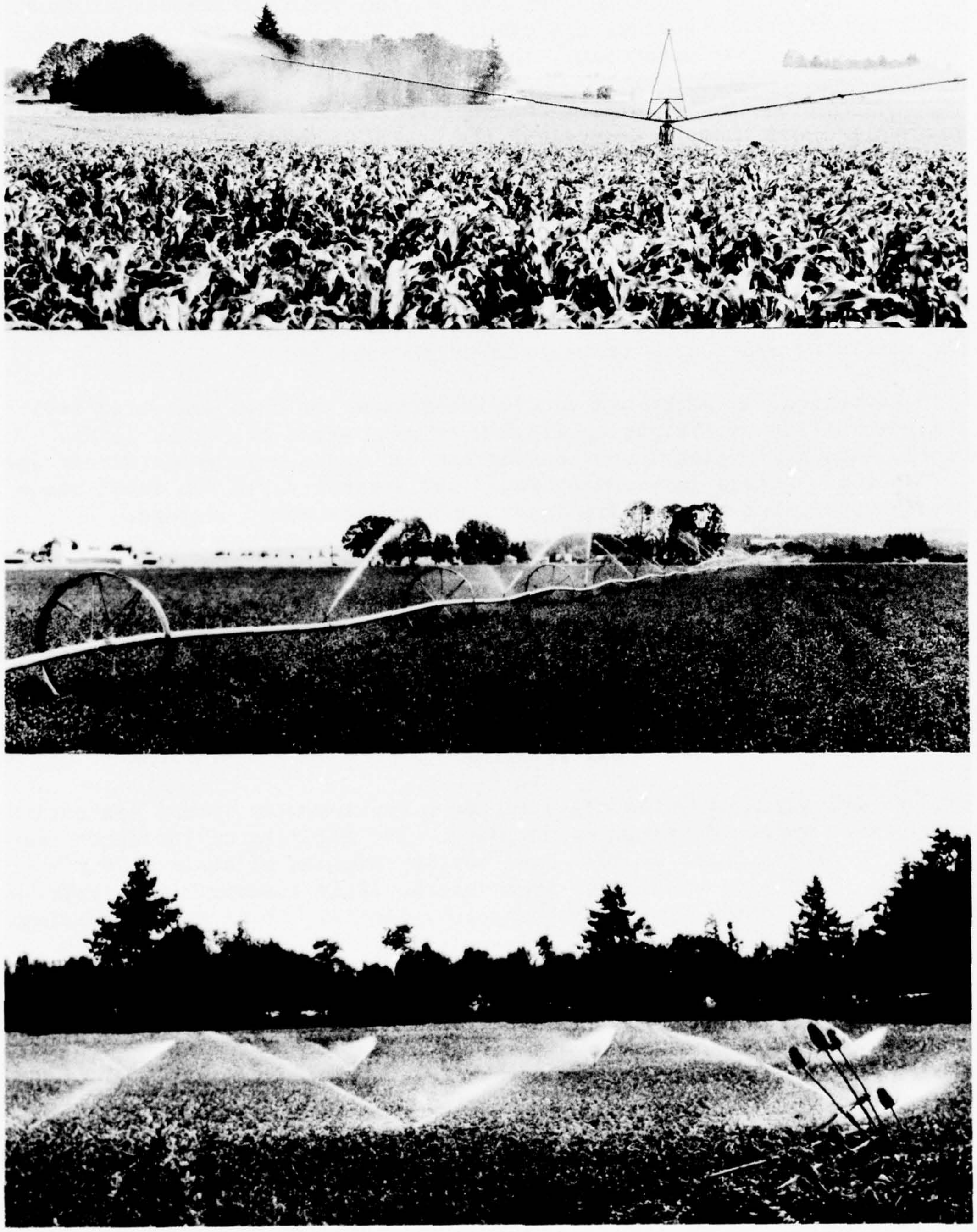
Diversion and water-use requirements have not been projected for the possibility of irrigating 250,000 or more acres of forest lands. Little data are available on consumptive use requirements for forest land irrigation. Future development would not seriously tax the total basin water supply, but may require major projects for water storage.

In light of recent court decisions, the question of regulatory and jurisdictional responsibilities for waters originating on Federal lands is of considerable importance because of the impact that could result on all downstream water rights. Closely related to this problem is the need to adjudicate water rights on the remaining stream systems in the basin. Until all waters have been adjudicated, uncertainties will continue to exist on present claims and this will compound the problem of developing future water-use projects and programs.

Waterlogging of soils could become a problem with future irrigation development unless drainage is adequate. The majority of the lands projected to be irrigated by 2020 have varying degrees of drainage deficencies. Extensive contiguous areas particularly susceptible to this waterlogging problem lie in the Long Tom, Santiam, Coast Range, Pudding, and Tualatin Subbasins.

Riverside pumping plants will serve a substantial portion of the future irrigation. Many of these facilities will be located within the proposed Willamette River Parks System (Greenway). Carefully considered development and use regulations within this area are necessary to insure that irrigation facilities can be constructed.

There are no significant water quality problems affecting irrigation at the present time. Chemical waste is the most likely to affect future quality but the probabilities of adverse effects on irrigation are fairly remote unless waste loading would occur near a diversion point.



Types of Sprinklers

ALTERNATIVE MEANS TO SATISFY DEMANDS

This part of the appendix is a presentation of alternative ways to furnish irrigation water for the demands projected in Part III. Consideration is given to the projected rate of irrigation development, alternative sources of supply, and several possible types of development. Probable irrigation water use is discussed in detail for both immediate- and long-range development. Tabular summaries are also presented for each of the target dates -- 1980, 2000, and 2020. In addition, the possibility for serving the undeveloped potentially irrigable lands remaining after year 2020 is discussed.

THE BASIN

The Willamette Basin contains 1,488,000 acres of potentially irrigable lands in addition to the 244,000 acres presently irrigated, totaling 1,732,000 acres of irrigable land. Based on anticipated changes in land use, an estimated 1,371,000 acres will be available for agricultural purposes by year 2020. As projected in Part III, 1,000,000 acres of these lands will be irrigated by 2020 -- requiring a total diversion of 2,460,300 acre-feet of water annually.

AVAILABLE WATER SOURCES

On an annual basis, there is more than enough water in the Willamette Basin to supply the projected 2020 irrigated acreage. However, the adverse seasonal distribution of rainfall and streamflow will require the use of existing storage and the construction of additional storage to insure that water is available when and where needed.

Irrigation season natural flow is heavily appropriated in Willamette River and its tributaries. Streamflows capable of supporting an increase in irrigation use exist only in a few places, primarily in the main stem. However, estimates of remaining natural flows cannot be accurately determined until rights on all basin streams have been adjudicated. Consequently, it is assumed that only those potential developments presently possessing water rights or permits will irrigate from these natural flows; these developments are expected to total 40-50,000 acres in the basin.

*Photo IV-1. Much of the water supply for future irrigation development will be drawn from the Willamette River as it traverses the basin.
(Oregon State Highway Department Photo)*

A considerable amount of Federal storage constructed by the Corps of Engineers is available for irrigation use in the basin. Eleven storage reservoirs located generally in the southern half of the basin have been constructed to serve the functions of flood control, irrigation, navigation, and power. As presently authorized, sufficient storage is available in these eleven constructed reservoirs and three other authorized reservoirs to adequately supply 455,220 acres of land. However, unless lands are developed cooperatively, this water can be utilized only by those landowners whose lands border certain streams. The discussion and the tables in the following sections refer to this Corps of Engineers storage as "Existing Storage."

Considerable potential also exists for construction of additional storage reservoirs. Suitable damsites are available on many streams, and some could provide the most economical water supply for lands which are too high or too distant to utilize existing Federal storage. The authorized Scoggins reservoir in the Tualatin Subbasin is an example of a new reservoir supplying a need that could not be met from existing reservoirs.

Some potential exists in the basin for irrigation of new lands by farm pond development, but this depends on the availability of a suitable pond site and water source on the farm. New irrigation development from farm ponds is expected to represent only a minor part of the overall expansion of irrigation in the basin.

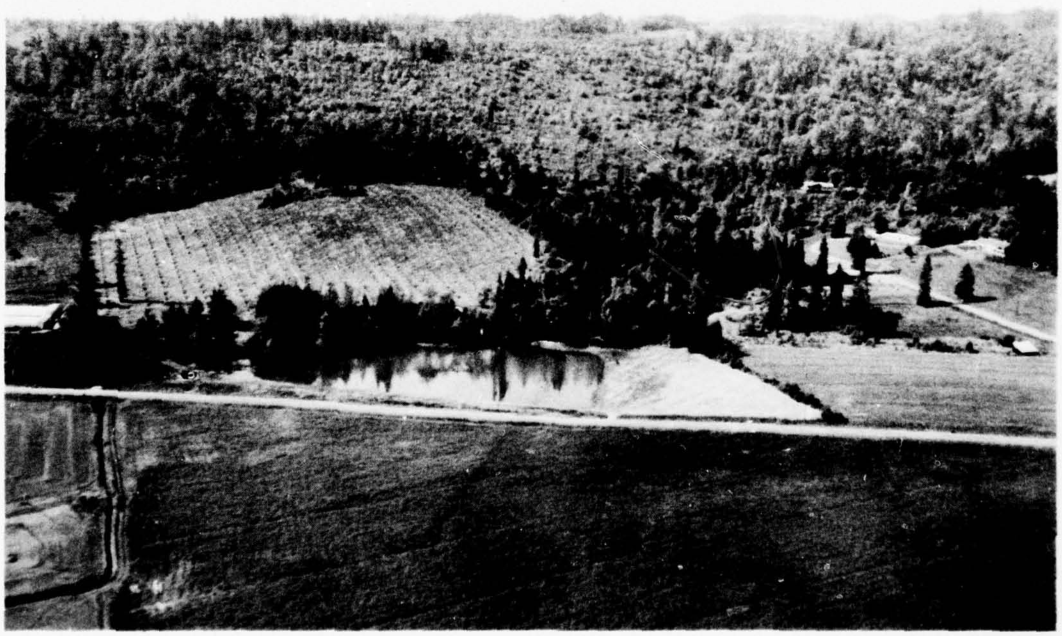


Photo IV-2. Farm ponds such as this one near Salem represent an opportunity for some landowners to develop small storage on an individual basis.

Ground-water sources sufficient to supply irrigation to "new" lands occur in several parts of the basin. Generally, adequate supplies of ground water can be obtained both in the recent alluvium along the Willamette River and larger tributaries and in a few areas of older bench soils such as the French Prairie area in the Pudding Subbasin. The better wells yield about 1,000 gallons per minute, enough to irrigate about 150 acres. Therefore, it is expected that ground water will continue to be developed on an individual basis. An exception could be the French Prairie area where the ground-water resource might prove extensive enough to justify project irrigation development based on clusters of wells.

PROBABLE DEVELOPMENT

Future irrigation development, summarized in Table IV-1, is expected to occur through both individual and group efforts. Individual development will continue throughout most of the basin. However, cooperative development will provide the means to irrigate most of the remaining lands which are isolated from water sources.

Table IV-1

Projected Irrigation Development by Source of Supply, Willamette Basin

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (Acres
Individual					
1965	117,270	1,940	--	101,400	220,610
1980	120,000	11,000	--	121,000	252,000
2000	120,000	17,000	--	189,000	326,000
2020	122,000	23,000	--	218,000	363,000
Cooperative					
1965	22,650	400	--	--	23,050
1980	54,000	42,000	82,000	--	178,000
2000	70,000	190,000	264,000	--	524,000
2020	70,000	251,000	316,000	--	637,000
Total					
1965	139,920	2,340	--	101,400	243,660
1980	174,000	53,000	82,000	121,000	430,000
2000	190,000	207,000	264,000	189,000	850,000
2020	192,000	274,000	316,000	218,000	1,000,000

Individual Development

It is anticipated that most farmers desiring to irrigate will choose to do so on an individual basis if it is at all practical. The areas where individual development appears feasible were analyzed, and estimates were made of the acreage that will probably be irrigated in this manner.

Ground water will be the primary water source for individual development, and the acreage irrigated from this source is estimated to more than double by 2020. The new wells are expected to be drilled in the same general areas where irrigation wells are currently in use -- along the Willamette River and its large eastern tributaries, in the French Prairie area, and in other smaller areas in the valley.

Natural streamflow is an ideal source for lands bordering streams. However, the natural flow in many tributaries is being fully utilized during the irrigation season and further development will require storage. Farm ponds represent an opportunity for some landowners to develop small storage on an individual basis, and they are expected to increase in number throughout the basin.

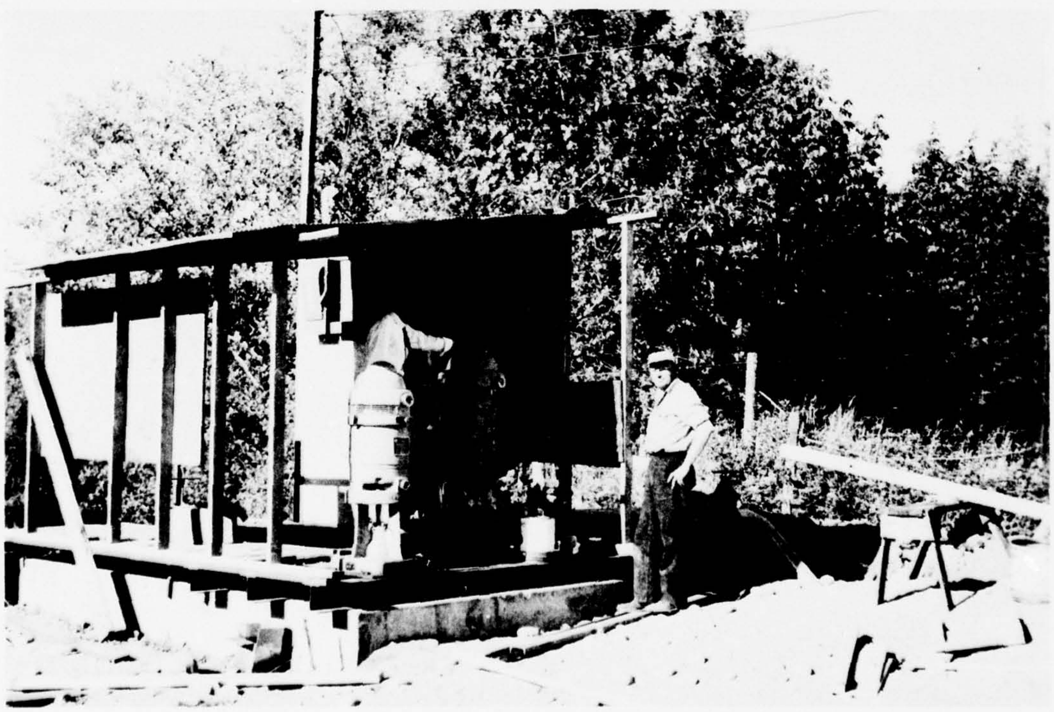


Photo IV-3. Cooperative projects such as this pumping plant near Stayton will provide the means for most new irrigation development. (U.S. Department of Agriculture Photo)

Stored water is available to landowners bordering those streams on which Federal reservoirs have been constructed. In 1965, 1,940 acres were irrigated on an individual basis from reservoir releases on Long Tom and North Santiam Rivers. Additional use is expected on these streams and new developments of this nature are expected on other streams where Federal storage is available.

Cooperative Development

Approximately 23,000 acres representing 14 community projects have been developed in the basin. Most of this land is located in the Pudding and Santiam Subbasins and is supplied from natural flows; about 400 acres are supplied by existing Federal storage. Expansion of these districts and the creation of additional cooperative projects are expected.

Planning is well advanced on most of the projects expected to be constructed by 1980. Project areas associated with future developments are shown on Maps IV-1 and IV-2.

Development by 1980

In the next several years, Federal and Federally assisted projects, either authorized or considered as assured, are expected to bring approximately 70,000 acres under irrigation. These consist of the McKay-Rock Creek, Lower Amazon-Flat Creek and Beaver Creek watershed projects (Map IV-1) and the Tualatin, Monmouth-Dallas, and Red Prairie Projects (Map IV-2). More than half of this acreage will be supplied from new storage reservoirs, and the remainder from natural flows and existing storage.

Other projects expected to be developed by 1980 would irrigate about 85,000 acres. Some of this development will take place within the small watershed projects recommended for early action by the Soil Conservation Service. Carlton Division on the North Yamhill River, under study by the Bureau of Reclamation, is expected to be developed by 1980. These projects are shown on Maps IV-1 and IV-2. Other development will result from expansion of existing community projects and the development of additional private projects, some with Federal assistance, primarily utilizing existing Federal storage. Potential for these other developments exists along the Willamette River and its larger tributaries.

Long-Range Development

It is anticipated that there will be a large expansion in the irrigated acreage of the basin between 1980 and 2020. Since the opportunities for development on an individual basis are limited, a major portion of this expansion will come about through group effort. By 2020, it is estimated that a total of 637,000 acres will be irrigated on a cooperative basis, mostly within the areas designated as opportunities for project development on Map IV-2. Reconnaissance studies indicate that it would be economically feasible to irrigate these lands through community-type development.

Water-Use Summary

Projections of irrigation development for the basin indicate a rapid increase in irrigation water use, especially during the 1965 to 2000 period. Current and projected irrigated acreages, annual irrigation diversion requirements, and estimated return flows for the development anticipated in the basin are shown in Table IV-2. The monthly estimated distribution of the annual diversion requirement in percent is May 9, June 26, July 31, August 24, and September 10.

Most return flows from irrigated lands because of sprinkler application are expected to enter the ground-water table and then return to the stream channels. The monthly distribution of estimated return flows by percent are May 5, June 12, July 17, August 18, September 13, October 9, November 6, and December through April, 4 each month.

MAJOR ALTERNATIVES

Major alternatives for sources of water beyond the use of natural flows that could be developed are the use of (1) existing storage, (2) new storage, and (3) ground water. These sources can be developed either individually or cooperatively depending on specific conditions in a particular location. The opportunities for individual and cooperative development are discussed in detail in the subbasin's presentations following.

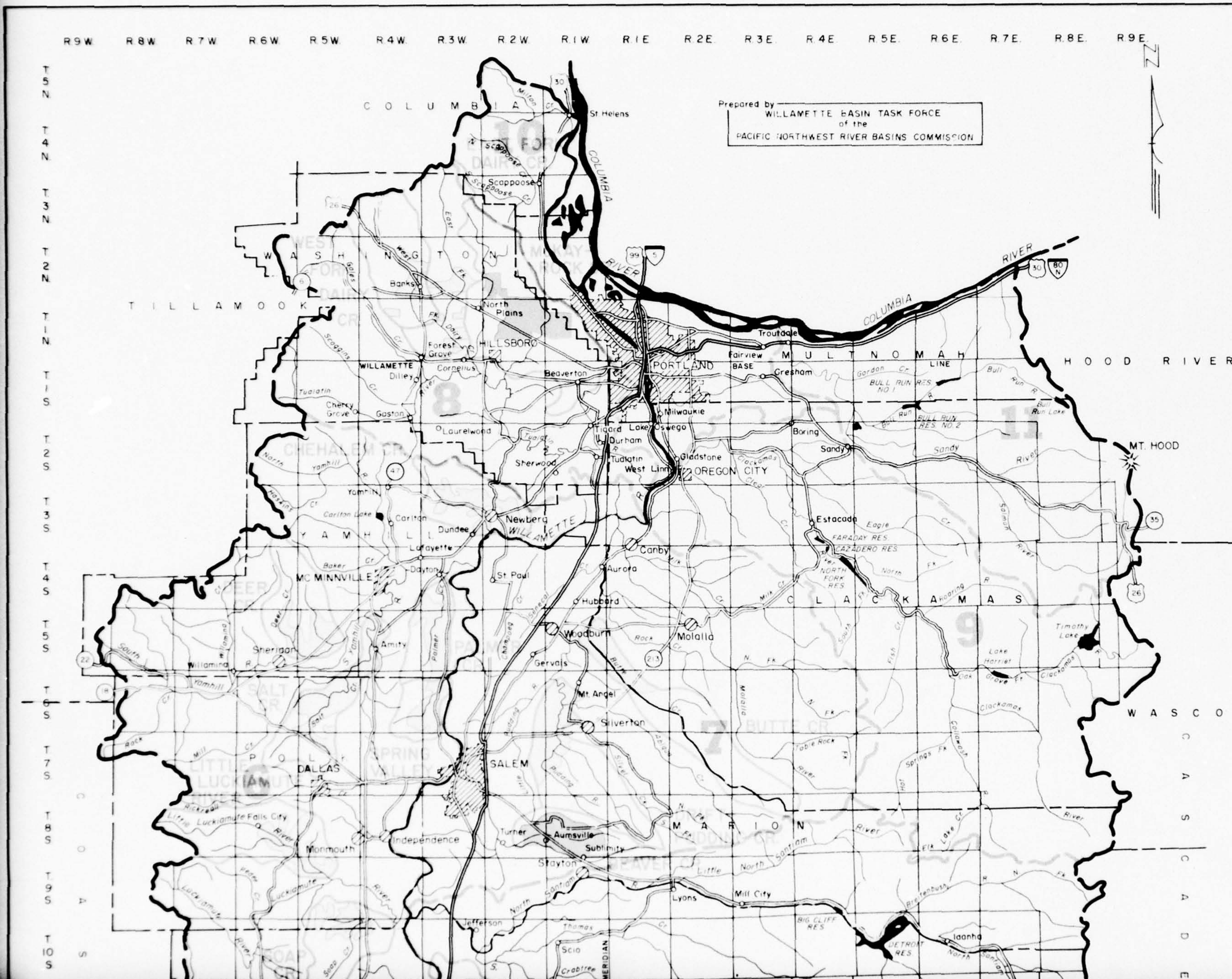
Alternative opportunities exist for development in some areas as shown on Maps IV-1 and IV-2. Generally this occurs as an alternative between a small reservoir project planned to serve a few thousand acres and a larger development. In most cases, the plans will be compatible and both could be constructed in the same general area. In other cases, the development of one will preclude development of the other.

The alternative means to satisfy demands presented herein are based on a single-purpose irrigation point of view. Appendix M - Plan Formulation contains the evaluations of multipurpose water needs and framework plans to best satisfy these needs.

REMAINING POTENTIAL AFTER YEAR 2020

It is projected that about 371,000 acres of potentially irrigable (dry) land will still remain in the basin by 2020. Except for Columbia Subbasin, this land will be distributed throughout the basin. The irrigated acreage will continue to increase after 2020 but at a slower rate than is anticipated for the period prior to that time.

By 2020, most of the lands located near available water supplies will be irrigated. The remaining lands will require greater expenditures for irrigation facilities than those developed prior to 2020, and some may never be irrigated. However, the irrigated lands are expected to obtain water supplies either from new or existing storage reservoirs.



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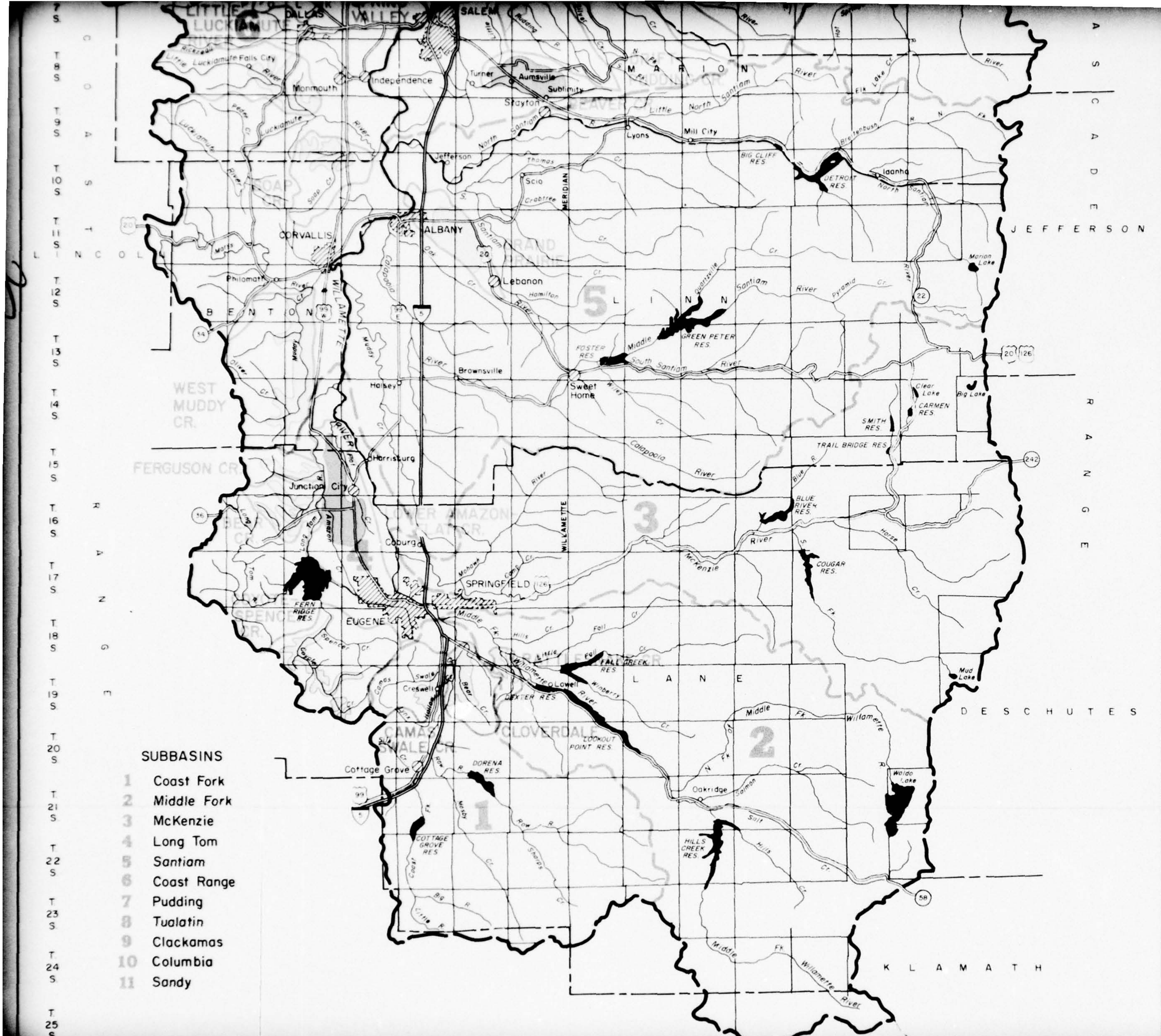
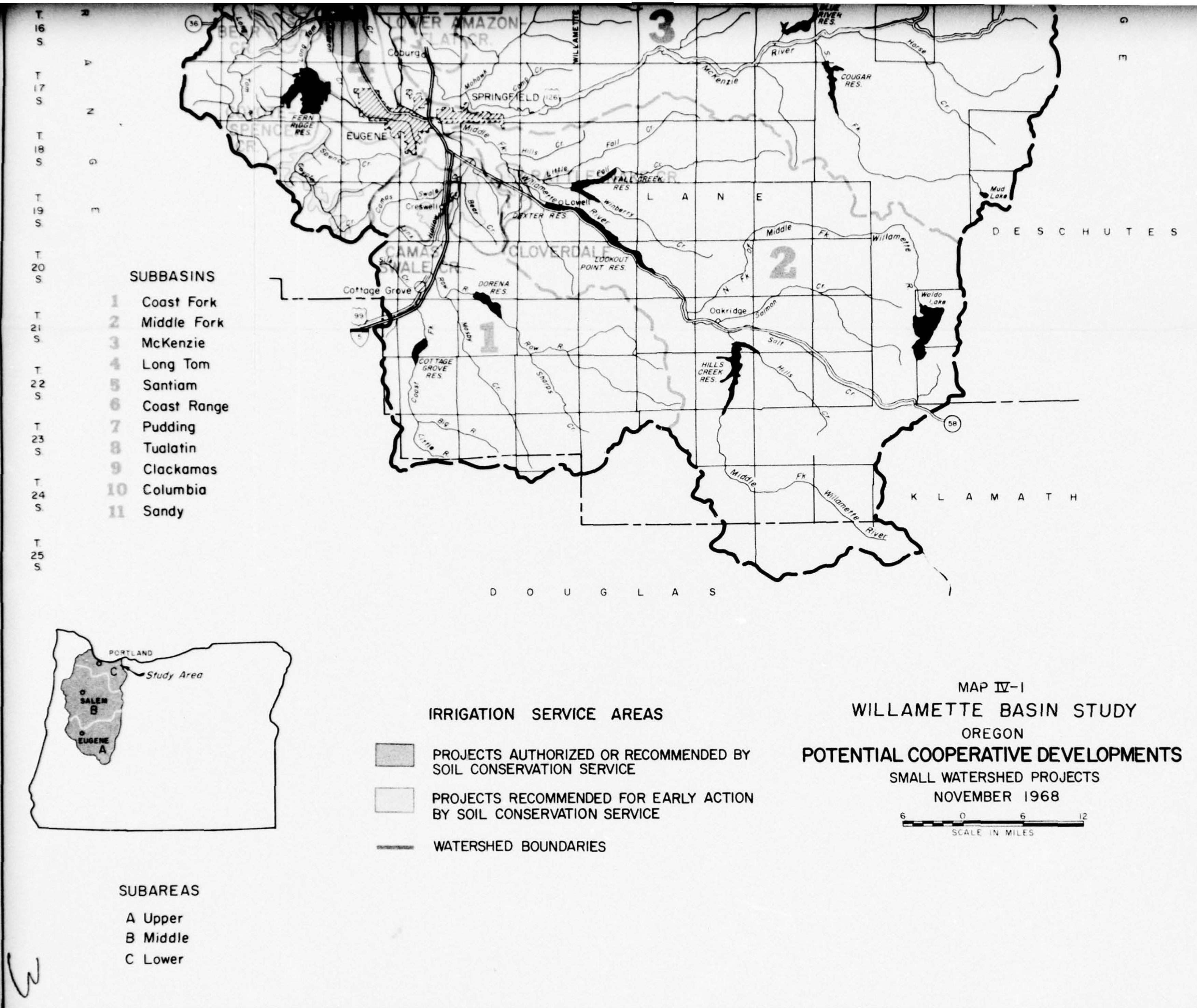
T5N T4N T3N T2N T1N T1S T2S T3S T4S T5S T6S T7S T8S T9S T10S
COLUMBIA
TILLAMOOK
WASHINGTON
MULTNOMAH
HOOD RIVER
CLACKAMAS
WASCO
YAMHILL
POLK
MARION
COAST
CASCADE
COLUMBIA RIVER
WILLAMETTE
MT. HOOD
St. Helens
Scappoose
Banks
North Plains
Forest Grove
HILLSBORO
Cornelius
Dilley
Cherry Grove
Gaston
Laurelwood
Beaverton
PORTLAND
Troutdale
Fairview
Gresham
Milwaukie
Lake Oswego
Tigard
Durham
Tualatin
West Linn
Gladstone
OREGON CITY
Sherwood
Boring
Sandy
Estacada
Yamhill
Carlton
Carlton Lake
Dundee
Newberg
Lafayette
Dayton
MC MINNVILLE
St. Paul
Canby
Aurora
Hubbard
Woodburn
Gervais
Molalla
Mt. Angel
Silverton
Sheridan
Willamina
Amity
DALLAS
SALEM
Falls City
Monmouth
Independence
Turner
Aumsville
Sublimity
Stayton
Lyons
Mill City
Jefferson
Scio
Idanha
BULL RUN RES. NO. 1
BULL RUN RES. NO. 2
Bull Run Lake
FARADAY RES.
CAZADERO RES.
NORTH FORK RES.
Timothy Lake
Lake Harriet
BIG CLIFF RES.
DETROIT RES.
MERIDIAN
BASE LINE



SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
C O A S T R A N G E
C A S C A D E R A N G E
LINCOLN
BENTON
LINN
MARION
LANE
JEFFERSON
DESCHUTES
KLAMATH
SALEM
ALBANY
CORVALLIS
EUGENE
SPRINGFIELD
Independence
Monmouth
Falls City
Turner
Aumsville
Sublimity
Stayton
Lyons
Mill City
Idanha
Jefferson
Scio
Lebanon
Brownsville
Sweet Home
Halsey
Harrisburg
Junction City
Coburg
Philomath
Creswell
Cottage Grove
Lowell
Oakridge
DETROIT RES.
BIG CLIFF RES.
GREEN PETER RES.
FOSTER RES.
TRAIL BRIDGE RES.
SMITH RES.
CARMEN RES.
BLUE RIVER RES.
COUGAR RES.
FERN RIDGE RES.
FALL CREEK RES.
DEXTER RES.
LOOKOUT POINT RES.
DORENA RES.
COTTAGE GROVE RES.
HILLS CREEK RES.
Waldo Lake
Marion Lake
Clear Lake
Big Lake
Mud Lake
WILLAMETTE
MERIDIAN
WEST MUDDY CR.
FERGUSON CR.
CLOVERDALE
CAMAS SWALE CR.



MAP IV-1
WILLAMETTE BASIN STUDY
OREGON
POTENTIAL COOPERATIVE DEVELOPMENTS
SMALL WATERSHED PROJECTS
NOVEMBER 1968
6 0 6 12
SCALE IN MILES
IRRIGATION SERVICE AREAS
PROJECTS AUTHORIZED OR RECOMMENDED BY SOIL CONSERVATION SERVICE
PROJECTS RECOMMENDED FOR EARLY ACTION BY SOIL CONSERVATION SERVICE
WATERSHED BOUNDARIES
SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
SUBAREAS
A Upper
B Middle
C Lower
PORTLAND
Study Area
SALEM
EUGENE
T. 16 S.
T. 17 S.
T. 18 S.
T. 19 S.
T. 20 S.
T. 21 S.
T. 22 S.
T. 23 S.
T. 24 S.
T. 25 S.
LANE
DOUGLAS
DESCHUTES
KLAMATH
EUGENE
SPRINGFIELD
Coburg
Cottage Grove
Creswell
Lowell
Oakridge
LOWER AMAZON
CLOVERDALE
CAMAS SWALE CR.
FERN RIDGE RES.
FALL CREEK RES.
DEXTER RES.
LOOKOUT POINT RES.
DORENA RES.
COTTAGE GROVE RES.
HILLS CREEK RES.
COUGAR RES.
BLUE RIVER RES.
Waldo Lake
Mud Lake
McKenzie River
Willamette River
Middle Fk Willamette R

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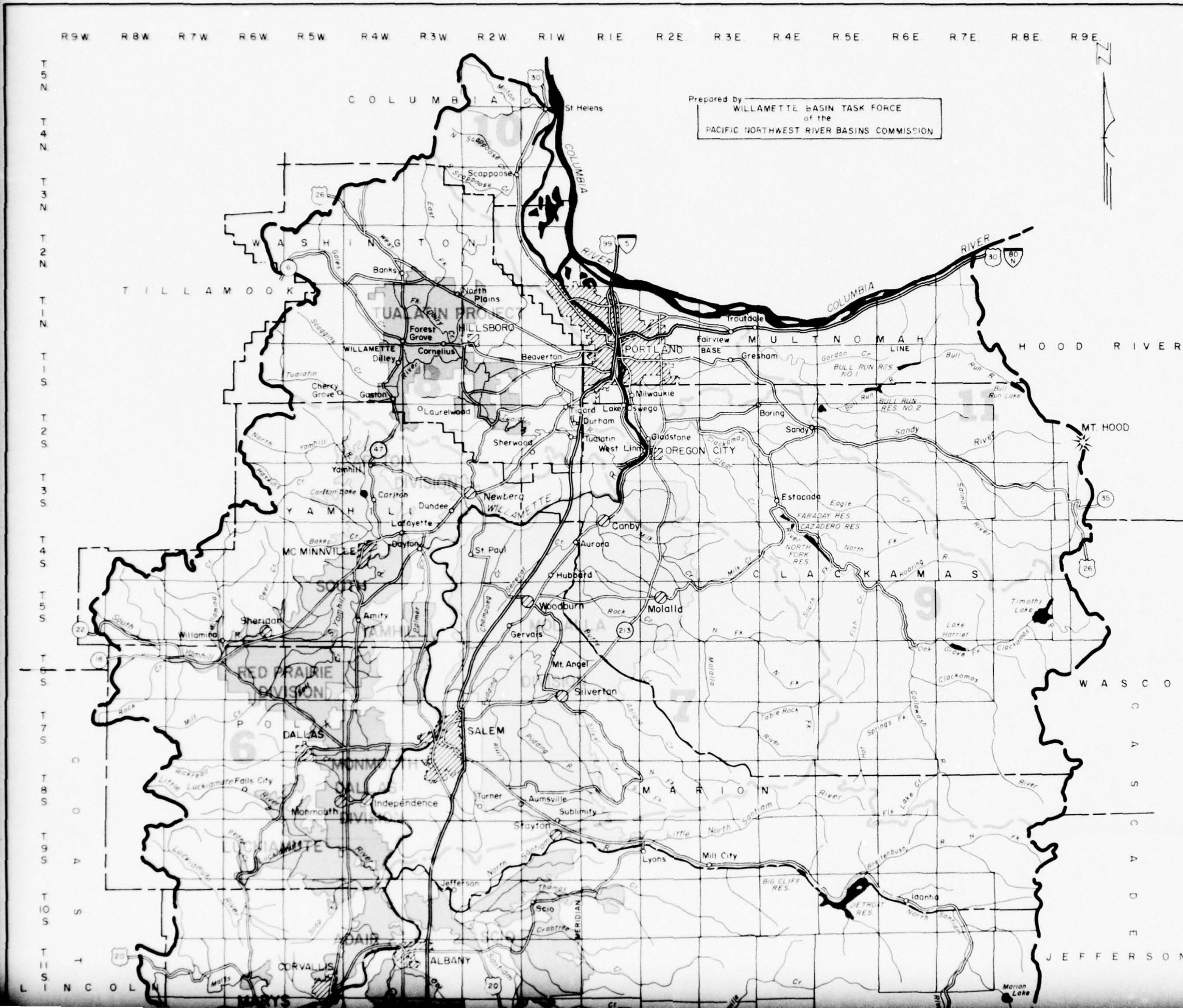

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T5N T4N T3N T2N T1N T1S T2S T3S T4S T5S T6S T7S T8S T9S T10S T11S
COLUMBIA
WASHINGTON
TILLAMOOK
MULTNOMAH
HOOD RIVER
CLACKAMAS
WASCO
CASCADE
JEFFERSON
MARION
YAMHILL
POLK
LINCOLN
COAST
COLUMBIA RIVER
St Helens
Scappoose
Banks
North Plains
TUALATIN PROJECT
Forest Grove
Cornelius
HILLSBORO
Dilley
Gaston
Cherry Grove
Laurelwood
Beaverton
PORTLAND
Troutdale
Fairview
Gresham
Milwaukie
Lake Oswego
Tigard
Durham
Tualatin
Sherwood
West Linn
Gladstone
OREGON CITY
Boring
Sandy
MT. HOOD
Estacada
FARADAY RES.
CAZADERO RES.
NORTH FORK RES.
BULL RUN RES. NO. 1
BULL RUN RES. NO. 2
Bull Run Lake
Timothy Lake
Lake Harriet
Yamhill
Carlton
Carlton Lake
Dundee
Newberg
WILLAMETTE
Lafayette
Dayton
MC MINNVILLE
St Paul
Canby
Aurora
Hubbard
Woodburn
Molalla
Gervais
Mt. Angel
Silverton
Sheridan
Willamina
Amity
SOUTH YAMHILL
RED PRAIRIE DIVISION
DALLAS
SALEM
Falls City
Independence
Monmouth
Turner
Aumsville
Sublimity
Stayton
Lyons
Mill City
BIG CLIFF RES.
DETROIT RES.
Idanha
Jefferson
Scio
MERIDIAN
ALBANY
CORVALLIS
Marion Lake
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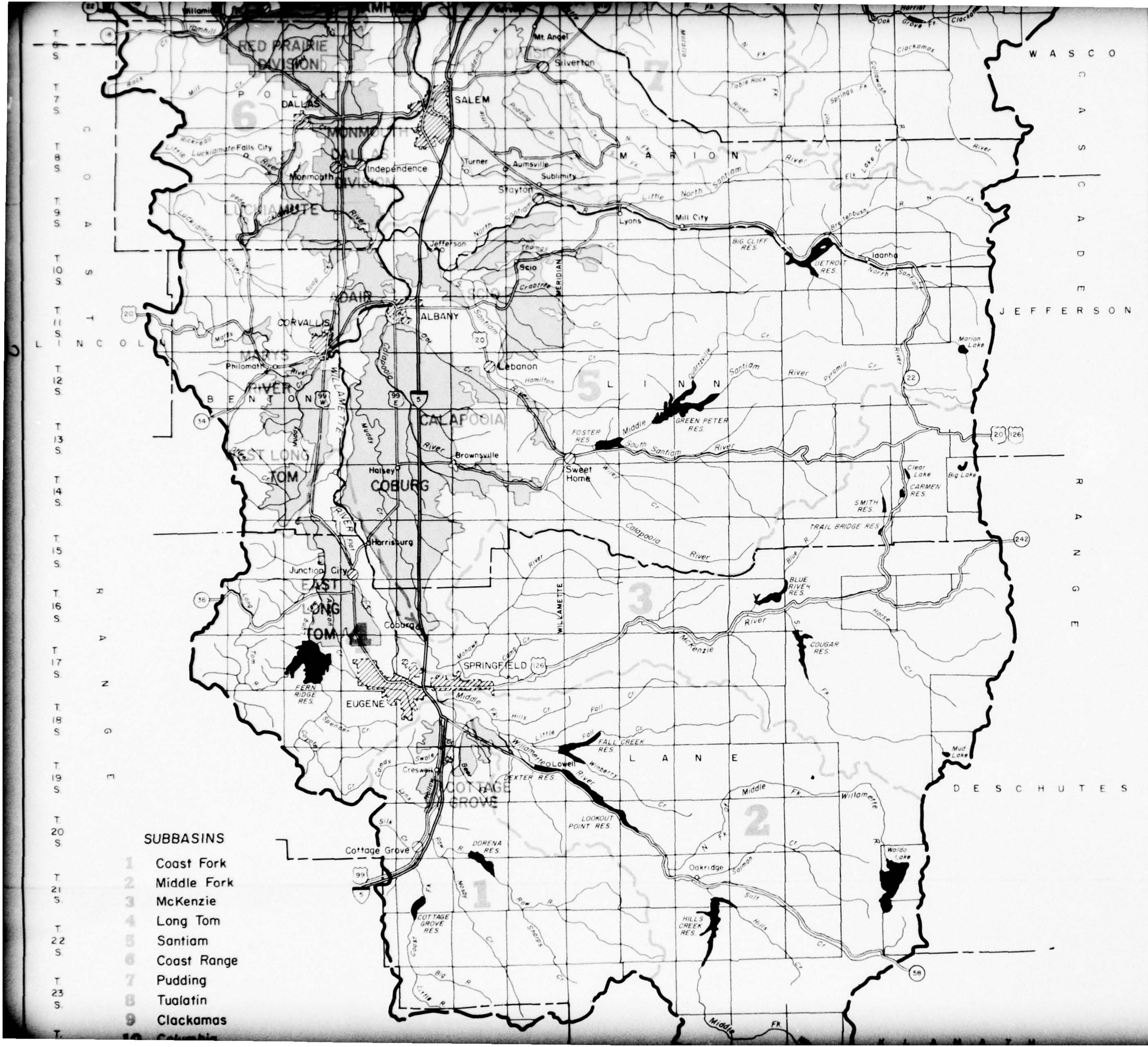
SUBBASINS
1 Coast Fork
2 Middle Fork
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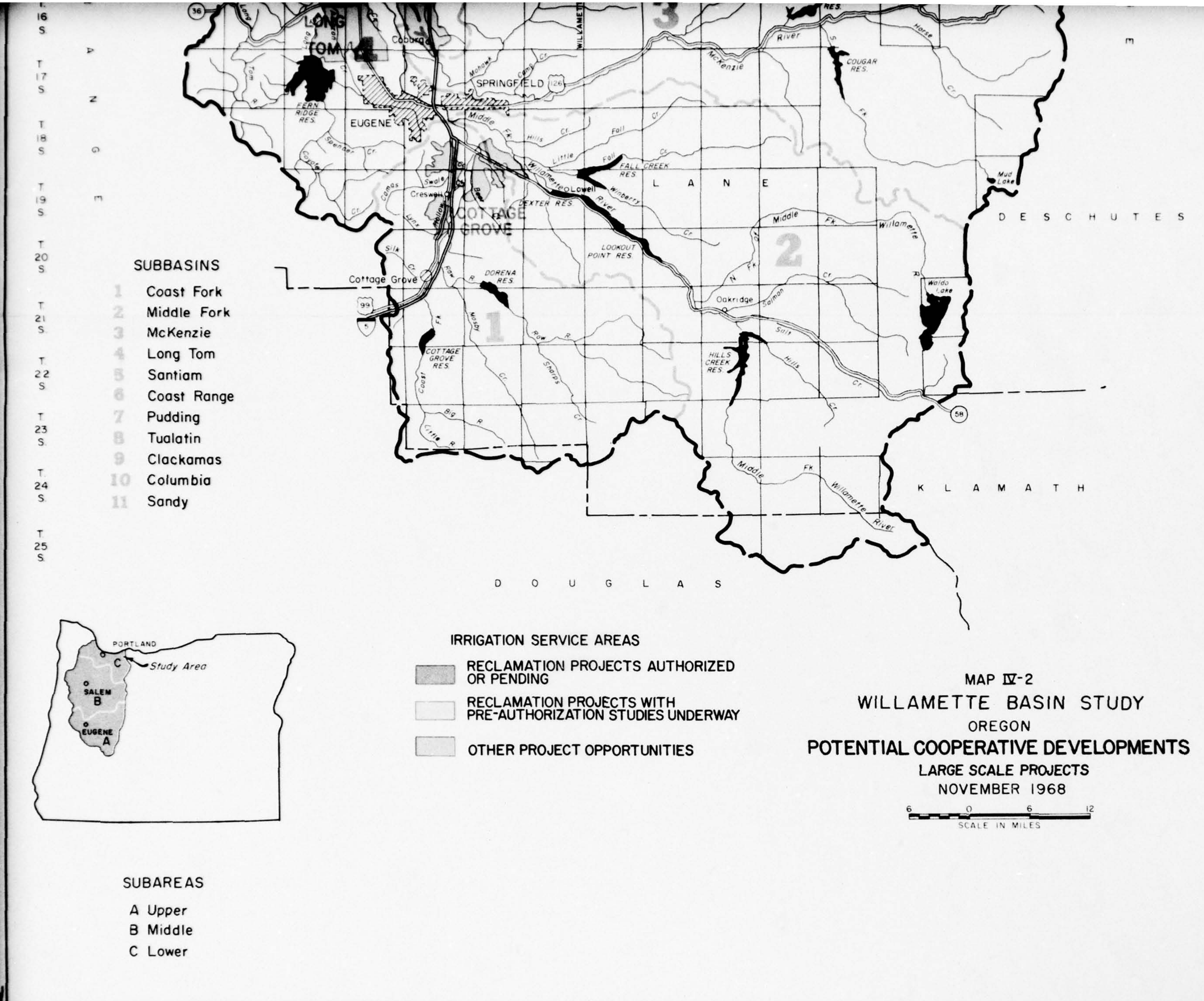
7 Pudding
8 Tualatin
9 Clackamas
WASCO
CASCADE
JEFFERSON
RANGE
DESCHUTES
COAST
RANGE
LINCOLN
POLK
MARION
LINN
LANE
BENTON
RED PRAIRIE DIVISION
MONMOUTH DALLAS DIVISION
LUCKIAMUTE
ADAIR
MARYS RIVER
EAST LONG TOM
CALAPOOIA
COBURG
EAST LONG TOM
COTTAGE GROVE
SCIO
SALEM
Silverton
Mt. Angel
DALLAS
Falls City
Monmouth
Independence
Turner
Aumsville
Sublimity
Stayton
Lyons
Mill City
Idanha
Jefferson
Scio
ALBANY
CORVALLIS
Philomath
Lebanon
Brownsville
Halsey
Harrisburg
Junction City
Sweet Home
Coburg
SPRINGFIELD
EUGENE
Lowell
Creswell
Cottage Grove
Oakridge
DETROIT RES.
BIG CLIFF RES.
GREEN PETER RES.
FOSTER RES.
CLEAR LAKE
CARMEN RES.
SMITH RES.
TRAIL BRIDGE RES.
BLUE RIVER RES.
COUGAR RES.
FERN RIDGE RES.
FALL CREEK RES.
DEXTER RES
LOOKOUT POINT RES.
DORENA RES.
COTTAGE GROVE RES.
HILLS CREEK RES.
Waldo Lake
Marion Lake
Big Lake
Mud Lake
WILLAMETTE
MERIDIAN



MAP IV-2
WILLAMETTE BASIN STUDY
OREGON
POTENTIAL COOPERATIVE DEVELOPMENTS
LARGE SCALE PROJECTS
NOVEMBER 1968
6 0 6 12
SCALE IN MILES
IRRIGATION SERVICE AREAS
RECLAMATION PROJECTS AUTHORIZED OR PENDING
RECLAMATION PROJECTS WITH PRE-AUTHORIZATION STUDIES UNDERWAY
OTHER PROJECT OPPORTUNITIES
SUBBASINS
1 Coast Fork
2 Middle Fork
3 McKenzie
4 Long Tom
5 Santiam
6 Coast Range
7 Pudding
8 Tualatin
9 Clackamas
10 Columbia
11 Sandy
SUBAREAS
A Upper
B Middle
C Lower
PORTLAND
Study Area
SALEM
EUGENE
LANE
DOUGLAS
DESCHUTES
KLAMATH
EUGENE
SPRINGFIELD
COTTAGE GROVE
Cottage Grove
Creswell
Lowell
Oakridge
Coburg
FERN RIDGE RES.
FALL CREEK RES.
DEXTER RES.
LOOKOUT POINT RES.
DORENA RES.
COTTAGE GROVE RES.
HILLS CREEK RES.
COUGAR RES.
Waldo Lake
Mud Lake
McKenzie
River
Willamette
Middle Fk
Willamette River
LONG TOM
T 16 S
T 17 S
T 18 S
T 19 S
T 20 S
T 21 S
T 22 S
T 23 S
T 24 S
T 25 S

Table IV-2
Summary of Projected Irrigation Development and Water Use, Willamette Basin

Source of Supply	Subbasin 6 Coast Range (Acres)	Subbasin 6 Coast Range (Acre-Feet)	Subbasin 7 Pudding (Acres)	Subbasin 7 Pudding (Acre-Feet)	Subbasin 8 Tualatin (Acres)	Subbasin 8 Tualatin (Acre-Feet)	Subbasin 9 Clackamas (Acres)	Subbasin 9 Clackamas (Acre-Feet)	Subbasin 10 Columbia (Acres)	Subbasin 10 Columbia (Acre-Feet)	Subbasin 11 Sandy (Acres)	Subbasin 11 Sandy (Acre-Feet)
Natural Flow & Farm Ponds												
1965	27,570	62,700	39,070	87,600	17,890	38,400	4,230	10,200	8,310	21,300	940	2,500
1980	53,000	145,800	41,000	112,800	17,800	55,600	4,700	14,700	6,000	18,800	900	2,800
2000	61,500	159,200	42,300	109,500	17,000	50,000	6,500	19,100	--	--	1,600	4,700
2020	62,500	152,800	42,700	104,400	15,000	41,700	7,200	20,000	--	--	3,200	8,900
Existing Storage												
1965	--	--	--	--	--	--	--	--	--	--	--	--
1980	14,000	38,500	12,000	33,000	--	--	--	--	--	--	--	--
2000	35,500	91,900	36,900	95,500	--	--	2,500	7,400	--	--	--	--
2020	49,900	122,000	46,400	113,400	--	--	2,500	6,900	--	--	--	--
New Storage												
1965	--	--	--	--	--	--	--	--	--	--	--	--
1980	46,000	126,500	8,600	23,700	23,000	71,900	--	--	--	--	--	--
2000	140,000	362,300	48,300	125,000	53,400	157,100	7,000	20,600	--	--	--	--
2020	172,600	421,900	59,700	145,900	49,600	137,800	7,000	19,400	--	--	--	--
Ground Water												
1965	16,400	38,000	33,680	78,000	1,200	3,200	2,100	5,500	2,450	6,500	900	2,400
1980	20,000	46,300	42,400	98,200	2,200	5,800	2,300	6,000	2,000	5,300	1,100	2,900
2000	25,000	57,900	88,500	204,900	3,600	9,500	6,000	15,800	--	--	2,400	6,300
2020	25,000	57,900	109,200	252,900	3,400	8,900	8,300	21,800	--	--	3,800	10,000
Total												
1965	43,970	100,700	72,750	165,600	19,090	41,600	6,330	15,700	10,760	27,800	1,840	4,900
1980	133,000	357,100	104,000	267,700	43,000	133,300	7,000	20,700	8,000	24,100	2,000	5,700
2000	262,000	671,300	216,000	534,900	74,000	216,600	22,000	62,900	--	--	4,000	11,000
2020	310,000	754,600	258,000	616,600	68,000	188,400	25,000	68,100	--	--	7,000	18,900
Return Flow												
1965		34,600		56,900		14,200		5,400		9,500		1,600
1980		145,200		104,300		55,000		8,200		9,600		2,200
2000		260,400		199,900		84,500		23,800		--		4,000
2020		276,300		220,900		69,100		24,600		--		6,700

Table IV-2 (continued)

Summary of Projected Irrigation Development and Water Use, Willamette Basin

Source of Supply	Willamette Basin (Acres)	Willamette Basin (Acre-Feet)	Subbasin 1 Coast Fork (Acres)	Subbasin 1 Coast Fork (Acre-Feet)	Subbasin 2 Middle Fork (Acres)	Subbasin 2 Middle Fork (Acre-Feet)	Subbasin 3 McKenzie (Acres)	Subbasin 3 McKenzie (Acre-Feet)	Subbasin 4 Long Tom (Acres)	Subbasin 4 Long Tom (Acre-Feet)	Subbasin 5 Santiam (Acres)	Subbasin 5 Santiam (Acre-Feet)
Natural Flow & Farm Ponds												
1965	139,920	324,400	3,230	7,600	1,560	3,800	4,640	11,700	5,510	13,100	26,970	65,500
1980	174,000	491,700	3,500	10,100	1,600	4,600	4,800	13,800	5,700	16,400	35,000	96,300
2000	190,000	502,500	3,700	10,000	1,600	4,300	5,000	13,500	6,100	16,500	44,700	115,700
2020	192,000	479,600	4,200	10,700	1,600	4,100	4,000	10,200	6,500	16,600	45,100	110,200
Existing Storage												
1965	2,340	5,600	--	--	--	--	--	--	1,500	3,600	840	2,000
1980	53,000	147,000	1,900	5,500	500	1,400	--	--	6,900	19,900	17,700	48,700
2000	207,000	539,600	8,400	22,700	1,500	4,100	--	--	13,900	37,700	108,300	280,300
2020	274,000	675,000	10,700	27,400	2,500	6,400	--	--	26,500	67,700	135,500	331,200
New Storage												
1965	--	--	--	--	--	--	--	--	--	--	--	--
1980	82,000	234,800	1,900	5,500	200	600	--	--	2,000	5,800	300	800
2000	264,000	705,900	2,800	7,600	500	1,300	1,000	2,700	7,000	18,900	4,000	10,400
2020	316,000	793,100	4,000	10,200	700	1,800	1,000	2,600	10,000	25,600	11,400	27,900
Ground Water												
1965	101,400	239,000	240	600	530	1,300	3,180	7,700	13,720	33,200	27,000	62,600
1980	121,000	284,900	700	1,700	700	1,700	4,200	10,200	15,400	37,300	30,000	69,500
2000	189,000	444,500	1,100	2,700	1,400	3,400	6,000	14,500	20,000	48,400	35,000	81,100
2020	218,000	512,600	1,100	2,700	2,200	5,300	5,000	12,100	20,000	48,400	40,000	92,600
Total												
1965	243,660	569,000	3,470	8,200	2,090	5,100	7,820	19,400	20,730	49,900	54,810	130,100
1980	430,000	1,158,400	8,000	22,800	3,000	8,300	9,000	24,000	30,000	79,400	83,000	215,300
2000	850,000	2,192,500	16,000	43,000	5,000	13,100	12,000	30,700	47,000	121,500	192,000	487,500
2020	1,000,000	2,460,300	20,000	51,000	7,000	17,600	10,000	24,900	63,000	158,300	232,000	561,900
Return Flow												
1965		197,000		2,800		1,700		6,900		17,100		46,300
1980		461,200		9,300		3,400		9,200		30,300		84,500
2000		838,100		16,700		5,000		11,400		45,200		187,200
2020		893,000		18,700		6,300		8,900		57,000		204,500

S U B B A S I N 1 - C O A S T F O R K

Irrigation in Subbasin 1 has developed slowly, with only about 3,500 acres presently irrigated. By 2020, it is expected that about 20,000, acres, 75 percent of the available potentially irrigable lands, will be irrigated.

SOURCES OF WATER

Because very little unappropriated irrigation season natural flow remains in this subbasin, future irrigation development will be based primarily on ground water and storage. The areas of recent alluvium along the Coast Fork Willamette and Row Rivers have ample ground water to irrigate the overlying lands plus some adjacent lands. The two existing Federal reservoirs -- Cottage Grove on the Coast Fork, and Dorena on Row River -- were authorized to serve the functions of flood control, navigation, and irrigation. The Bureau of Reclamation holds a permit which reserves 100,000 acre-feet of conservation storage in these two reservoris, a portion of which is available for irrigation use.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All presently irrigated lands have been developed on an individual basis, almost exclusively from surface-water sources. Irrigation development by 2020 through both individual and cooperative efforts, is expected to total 20,000 acres (Table IV-3). Water for about half of this development would come from existing storage.

Future individual development is expected to be less extensive than cooperative or project type, but some will probably occur along the Coast Fork and Row River using both ground water and streamflow. Construction of private farm ponds throughout the subbasin is expected to provide a source of supply for some of the lands along the minor tributaries. It is expected that about 7,300 acres will be irrigated by individuals by 2020.

By year 2020, 12,700 acres will probably be developed on a cooperative or project basis and will use stored water. The most economical source of water for most of these lands appears to be irrigation storage currently available in Cottage Grove and Dorena Reservoirs. This is particularly true for the three moderately large blocks of land along the Coast Fork which total about 15,000 potentially irrigable acres. Two of these blocks lie west of the river -- one just south and the other north of Creswell -- the third is east of the river in the vicinity of Cloverdale. By 2020, it is estimated that a total of 8,700 acres of these lands will be irrigated by cooperative efforts using storage water released from the two upstream reservoirs. Reconnaissance studies by the Bureau of Reclamation show that it is feasible to irrigate these lands (Map IV-2). The Cloverdale small watershed project, under study by the Soil Conservation Service, could irrigate 1,800 acres of these lands (Map IV-1).

Table IV- 3

Projected Irrigation Development by Source of Supply
Subbasin 1 - Coast Fork

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	3,230	--	--	240	3,470
1980	3,500	900	--	700	5,100
2000	3,700	1,400	--	1,100	6,200
2020	4,200	2,000	--	1,100	7,300
Cooperative					
1965	--	--	--	--	--
1980	--	1,000	1,900	--	2,900
2000	--	7,000	2,800	--	9,800
2020	--	8,700	4,000	--	12,700
Total					
1965	3,230	--	--	240	3,470
1980	3,500	1,900	1,900	700	8,000
2000	3,700	8,400	2,800	1,100	16,000
2020	4,200	10,700	4,000	1,100	20,000

Other irrigable lands which lie in fingers along small tributaries may be more economically supplied from small reservoirs on these tributaries. The Camas Swale small watershed project, presently being studied by the Soil Conservation Service, could serve an estimated 1,400 acres near Creswell from new storage. Other opportunities also exist for this type of development, and by 2020 a total of 4,000 acres probably will be developed in this manner.

An alternative to serving lands in the Cloverdale area from existing upstream storage on the Coast Fork would be a transbasin diversion from the Middle Fork Willamette River. Water could be pumped through the saddle near Pleasant Hill to irrigate some 6,000 acres.

Another alternative to the use of storage from the existing Cottage Grove and Dorena Reservoirs is to construct new reservoirs in the subbasin. There are several sites available, both large and small, which appear to have potential.

S U B B A S I N 2 - M I D D L E F O R K

The Middle Fork Subbasin contains a relatively small amount of potentially irrigable lands, and only 2,090 acres are presently irrigated. Irrigation is expected to expand gradually to about 7,000 acres by 2020. About 17,600 acre-feet will be required annually to serve these lands -- some 12,000 acre-feet more than is presently required .

SOURCES OF WATER

There appears to be an abundant supply of water available for the relatively small acreage of land expected to be irrigated in this subbasin. Most of the potentially irrigable lands are underlain by alluvial deposits which yield about 500 gallons per minute to properly constructed wells penetrating these deposits. Lands presently irrigated from natural flow of the Middle Fork Willamette River are not experiencing any shortages, and with the storage available upstream, further increases in irrigation are possible. However, irrigators on Rattlesnake and Lost Creeks occasionally experience shortages.

This subbasin contains three Federal storage reservoirs -- Lookout Point, Hills Creek, and Fall Creek. Some 340,000 acre-feet of conservation storage in Lookout Point Reservoir are covered by a Bureau of Reclamation storage permit. Application for a storage permit has been filed on storage in the other two reservoirs; storage has been assigned to irrigation in each. The potentially irrigable lands in this subbasin generally have access to either ground water, streamflow, or storage water.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All past irrigation development has been on an individual basis. Some 530 acres are supplied from ground water and 1,560 acres from surface water. Future development is expected to occur through both individual and cooperative efforts . By 2020 more than 65 percent of the irrigated lands will be served from existing storage and ground water. (Table IV-4).

Individual development will total 4,300 acres by 2020. More than half will be supplied from ground water, probably in areas adjacent to Middle Fork Willamette River. Greater use of streamflow from existing storage on the Middle Fork and Fall Creek is also expected. Additionally, new farm pond construction will increase slightly; however, this additional irrigation will probably be offset by the loss of irrigated land to urban encroachment near the cities of Eugene and Springfield.

The remaining 2,700 acres of land expected to be irrigated by 2020 will probably be developed on a cooperative or project basis and will use stored water.

Table IV- 4

Projected Irrigation Development by Source of Supply,
Subbasin 2 - Middle Fork

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	1,560	--	--	530	2,090
1980	1,600	--	--	700	2,300
2000	1,600	500	--	1,400	3,500
2020	1,600	500	--	2,200	4,300
Cooperative					
1965	--	--	--	--	--
1980	--	500	200	--	700
2000	--	1,000	500	--	1,500
2020	--	2,000	700	--	2,700
Total					
1965	1,560	--	--	530	2,090
1980	1,600	500	200	700	3,000
2000	1,600	1,500	500	1,400	5,000
2020	1,600	2,500	700	2,200	7,000

An area where cooperative development appears probable is the block of land near Pleasant Hill. By 2020, it is estimated that 2,000 acres will be irrigated by pumping reservoir releases from existing storage on the Middle Fork. The Soil Conservation Service is studying a small watershed project on Rattlesnake Creek which would irrigate an estimated 800 of these acres. Opportunities also exist for small reservoir development on tributaries to Middle Fork Willamette River, and an estimated 700 acres probably will be brought under irrigation in this manner by 2020.

The estimated 2,000 acres near Pleasant Hill could be supplied by a transbasin diversion from Subbasin 1, by developing these lands in combination with adjacent lands in the Cloverdale area.

S U B B A S I N 3 - M C K E N Z I E

Because of its proximity to the expanding Eugene-Springfield metropolitan area, McKenzie Subbasin is expected to reach a peak irrigation development of about 12,000 acres by year 2000, and then decline. The subbasin's abundant supplies of water can easily meet the peak demand.

SOURCES OF WATER

Legal restrictions related to irrigation in this subbasin are set by the State Water Resources Board program of October 24, 1958. Under this program, irrigation is not a recognized use of McKenzie River waters above river mile 76.9. However, since the potentially irrigable lands in this subbasin are located considerably downstream from that point, the program will not limit irrigation development.

Future irrigation will be based on ground water, McKenzie River flow, farm ponds, and storage. Summer streamflows in the Mohawk River and Camp Creek are inadequate to support an increase in irrigation from natural flow. However, several storage sites exist on Mohawk River which, if economically justified, could supply lands along that stream. Considerable water is available during the irrigation season in McKenzie River from storage in upstream Federal reservoirs. The three existing or authorized Federal reservoirs in this subbasin -- Cougar Reservoir on South Fork McKenzie River, Blue River Reservoir on Blue River, and Gate Creek Reservoir on Gate Creek -- are authorized to serve the function of irrigation as well as other purposes.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

Nearly all of the irrigation developed thus far has been on an individual basis. Only about 200 acres are irrigated by cooperative means, all from natural flow. Future development is expected to occur primarily through individual effort. By 2020, half the projected irrigated acreage is expected to be served from ground-water supplies, as shown in Table IV-5.

Additional individual irrigation from ground water is anticipated in the areas adjacent to the Mohawk and lower McKenzie Rivers, and from streamflow along the McKenzie River. Some additional farm pond construction is also expected in scattered areas of the subbasin.

The potentially irrigable lands of this subbasin are generally scattered and close to a reliable water supply. Therefore, individual development will probably take place on a majority of the lands. One small irrigation project is in operation near Springfield, but due to its location, it is not expected to exist beyond 1980. There is an opportunity for cooperative development along the Mohawk River if storage were made available on that stream. Based on this potential, it is estimated that 1,000 acres will be irrigated from new storage by 2020.

Table IV-5

Projected Irrigation Development by Source of Supply,
Subbasin 3 - McKenzie

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	4,440	--	--	3,180	7,620
1980	4,800	--	--	4,200	9,000
2000	5,000	--	--	6,000	11,000
2020	4,000	--	--	5,000	9,000
Cooperative					
1965	200	--	--	--	200
1980	--	--	--	--	--
2000	--	--	1,000	--	1,000
2020	--	--	1,000	--	1,000
Total					
1965	4,640	--	--	3,180	7,820
1980	4,800	--	--	4,200	9,000
2000	5,000	--	1,000	6,000	12,000
2020	4,000	--	1,000	5,000	10,000

Alternative sources of water are available to irrigate the lands in the Mohawk Valley. The primary alternative would be to pump water from McKenzie River in lieu of constructing storage on the Mohawk River to irrigate these lands. Studies indicate that this pumping plan is expensive because the lands are scattered and extensive pipelines or canals would be required.

SUBBASIN 4 - LONG TOM

Irrigation has been expanding rapidly during recent years in the Long Tom Subbasin. It is projected that irrigation development will increase more than threefold by year 2020 -- requiring the diversion of 158,300 acre-feet of water annually.

SOURCES OF WATER

Irrigation water supply is critical in the Long Tom watershed above Fern Ridge Reservoir as some of its tributary streams usually have no flow in late summer. A critical situation exists on Coyote Creek where summer flows are fully appropriated, and new water right applications are accepted by the State Engineer only if they are based upon water from storage. Future irrigation development in this subbasin will depend largely on storage of surplus winter runoff, pumping from the Willamette River, the use of ground water, and farm ponds. The only existing Federal storage in the subbasin is Fern Ridge Reservoir where the Bureau of Reclamation holds a permit for 95,000 acre-feet of conservation storage of which a portion is available for irrigation.

The Willamette River, flowing through the eastern edge of this subbasin, holds perhaps the largest potential as an irrigation water supply. Storage in upstream Federal reservoirs could be diverted from the Willamette River to irrigate a large portion of lands in this subbasin.

Ground-water supplies are available in part of the subbasin. The recent alluvium along both sides of the Willamette River can support additional irrigation. Other lands are generally deficient in ground-water supplies.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

Lands presently irrigated in this subbasin have all been developed on an individual basis. About 13,720 acres are supplied from ground water, and 7,010 acres from surface water of which some 1,500 acres use stored water from Fern Ridge Reservoir. Future development is expected to occur through both individual and cooperative efforts as shown on Table IV-6. By 2020, some 63,000 acres are expected to be under irrigation with about 42 percent of these lands being served from existing storage.

Additional individual developments using ground water as their source of supply are expected to occur along Willamette River. Further development is also expected on farms bordering the Long Tom River, using Fern Ridge Reservoir releases. Also, individual construction of new farm ponds is expected in scattered areas of the subbasin.

Of the 33,000 acres of land expected to be irrigated through cooperative efforts by 2020, about 23,000 will probably use existing Federal storage and the remaining 10,000 acres will use storage from new small reservoirs.

Table IV-6

Projected Irrigation Development by Source of Supply, Subbasin 4 - Long Tom

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	5,510	1,500	--	13,720	20,730
1980	5,700	3,400	--	15,400	24,500
2000	6,100	3,500	--	20,000	29,600
2020	6,500	3,500	--	20,000	30,000
Cooperative					
1965	--	--	--	--	--
1980	--	3,500	2,000	--	5,500
2000	--	10,400	7,000	--	17,400
2020	--	23,000	10,000	--	33,000
Total					
1965	5,510	1,500	--	13,720	20,730
1980	5,700	6,900	2,000	15,400	30,000
2000	6,100	13,900	7,000	20,000	47,000
2020	6,500	26,500	10,000	20,000	63,000

An opportunity for large-scale irrigation development exists in this subbasin. The East Long Tom area (Map IV-2) contains nearly 33,000 acres of potentially irrigable land. This area can be served most economically from a combination of Fern Ridge and upstream storage on the Willamette system. Reconnaissance studies by the Bureau of Reclamation indicate a project to serve the lands in this area is economically feasible.

Part of this area is in the Soil Conservation Service's authorized Lower Amazon-Flat Creek Project (Map IV-1). Three thousand acres will be irrigated by this project, utilizing a pumping plant on Willamette River north of Eugene.

A significant part of this subbasin's remaining potentially irrigable lands are located either upstream from Fern Ridge Reservoir or along tributary streams where service from existing storage would not be economically feasible. These lands can best be served by new small reservoirs. Three such projects in this subbasin with an estimated 4,900 acres of new irrigation are being studied by the Soil Conservation Service. They are: Ferguson Creek (1,900 acres); Bear Creek (1,000 acres); and Coyote-Spencer Creeks (2,000 acres).

Alternative sources of water supply are limited in this subbasin. The only significant alternative is to supply a larger portion, or all, of these lands from the Willamette River.

S U B B A S I N 5 - S A N T I A M

The Santiam Subbasin has more operating irrigation irrigation projects than any other subbasin; moreover, it contains over half of the irrigation-project acreage in the Willamette Basin. Through the construction of new projects, expansion of present projects, and continuation of individual developments, it is expected that over one-half million acre-feet of wat er will be in use to irrigate 232,000 acres by 2020.

SOURCES OF WATER

Existing Federal reservoirs include Detroit on the North Santiam River and Green Peter and Foster on the South Santiam River. In addition, Holley Reservoir on Calapooia River and Cascadia Reservoir on the South Santiam River have been authorized for construction. The Bureau of Reclamation holds a permit for 300,000 acre-feet of conservation storage in Detroit Reservoir, a portion of which is for irrigation. Also, storage has been assigned to irrigation in the other four reservoirs. Numerous additional sites exist throughout the subbasin that are suitable for reservoirs. Farm pond sites are also numerous.

Ground-water supplies are abundant along the larger streams. Supplies are inadequate, however, along some of the smaller streams such as Muddy Creek and Calapooia River.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

Irrigation development is expected to increase from 54,800 acres at present to about 232,000 acres by 2020. Cooperative development will account for about three fourths of this total (Table IV- 7). Sources of supply will include ground water, natural flow, farm ponds, and new and existing storage. Use of all these sources will be expanded significantly, but the great bulk of the increase will be supplied from existing storage.

About 20,000 additional acres in the subbasin are expected to be developed on an individual basis by 2020. The majority of these will be supplied from ground water and lie in areas along the Willamette, the lower reaches of North and South Santiam Rivers, and the main stem of the Santiam. Additional use of streamflow is also foreseen on farms bordering these same rivers, and additional farm ponds are expected throughout the subbasin.

There is considerable potential within this subbasin for cooperative development, and in some areas this would be the only practical method. Nine separate developments in the subbasin have already been accomplished by cooperative effort. These groups irrigate 13,800 acres from natural flows and another 400 acres by releases from Detroit Reservoir. Several of these groups will be expanding and new groups will likely organize in the near future.

Table IV- 7

Projected Irrigation Development by Source of Supply, Subbasin 5 - Santiam

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	13,170	440	--	27,000	40,610
1980	14,000	2,700	--	30,000	46,700
2000	14,700	4,500	--	35,000	54,200
2020	15,100	5,500	--	40,000	60,600
Cooperative					
1965	13,800	400	--	--	14,200
1980	21,000	15,000	300	--	36,300
2000	30,000	103,800	4,000	--	137,800
2020	30,000	130,000	11,400	--	171,400
Total					
1965	26,970	840	--	27,000	54,810
1980	35,000	17,700	300	30,000	83,000
2000	44,700	108,300	4,000	35,000	192,000
2020	45,100	135,500	11,400	40,000	232,000

The Santiam Subbasin has several well-defined blocks of potentially irrigable lands which are well suited to cooperative or project-type development. One such project is in the Grand Prairie area in the vicinity of Albany and Lebanon (Map IV-1). Other opportunities for cooperative development on a somewhat larger scale exist in the Scio, Calapooia, and Coburg areas (Map IV-2).

The Grand Prairie area is defined by the Grand Prairie Water Control District and contains about 25,000 potentially irrigable acres. The area can probably be most economically supplied from South Santiam River. The Soil Conservation Service has planning well advanced on the Grand Prairie watershed project which includes provisions for irrigating about 3,400 acres. Estimates indicate that about 16,000 acres could ultimately be irrigated from the South Santiam River through the Pacific Power and Light Company's Albany Ditch. The remaining areas of the water control district could be supplied from upstream storage on the South Santiam River.

The Scio area contains about 54,000 potentially irrigable acres primarily between South Sanitam and North Santiam Rivers. This area lends itself to service from several sources. The most probably sources consist of a combination of existing Federal storage -- obtained by pumping from the South Santiam, North Santiam, and Santiam Rivers -- and new storage on Thomas Creek. Reconnaissance studies show that a project serve this area is economically feasible, and that the majority of the water should come from South Santiam River. The alternatives for this area consist primarily of varying the quantities of water from each source.

The Calapooia area includes about 67,000 potentially irrigable acres generally within the Brownsville-Albany-Lebanon triangle. Those lands in the upper drainage of Calapooia River can probably be supplied most economically from the authorized Holley Reservoir, and the remainder from existing storage on the South Santiam River. Reconnaissance studies indicate that the irrigation element of a project for this area is economically feasible. An alternative source of supply for these lands is the McKenzie or Willamette Rivers if this area were developed along with the Coburg area.

The Coburg area contains about 115,000 potentially irrigable acres which for the most part compose the East Muddy Creek drianage. Reconnaissance studies by the Bureau of Reclamation show that a project to serve this area is economically feasible. The area could probably be most economically supplied by a combination of the McKenzie and Willamette Rivers. These lands could also be supplied entirely by a diversion from McKenzie River and it is also physically possible to serve the entire area from the Willamette River.

SUBBASIN 6- COAST RANGE

The Coast Range Subbasin contains the greatest potential for irrigation of any subbasin in the Willamette. The presently irrigated acreage of 43,970 is expected to expand to 310,000 by 2020. About three-quarters of a million acre-feet of water will be required annually to serve these lands.

SOURCES OF WATER

Flowing for 113 miles on the eastern boundary of the subbasin, the Willamette River has a potential to meet a substantial part of the water needs for irrigation development. Two proposed cooperative projects -- Monmouth-Dallas and Palmer Creek -- have already made applications for use of Willamette River natural flows. These developments are planned to irrigate about 31,000 acres. Later expansion along the Willamette is expected to rely on upstream Federal storage for water supply.

The subbasin also contains several large streams, such as the Yamhill and Luckiamute Rivers, which head in the Coast Range and flow eastward to the Willamette River. These streams normally have relatively low flows during the irrigation season. Moreover, considerable irrigation development has taken place along the streams, resulting in heavy use of available summer flows. Based on the reports of private water surveys in the area, very little irrigation season natural flow remains. However, these streams have considerable storage potential and could contribute considerably to irrigation expansion in the area. Favorable storage sites exist on nearly every major stream in the subbasin, and considering the high annual runoff of these streams, it seems likely that this potential will be developed in the future.

A major part of this subbasin is poorly supplied with ground water relative to water needs. Marine and volcanic rocks that form the mountains and foothills of the Coast Range are so impermeable in places that they will not yield sufficient water for a domestic supply. In other places, the ground water is too salty for use. However, there are highly productive aquifers along the Willamette River and in a few scattered areas in the northern part of the subbasin which could supply future irrigation. Unfortunately, these areas comprise only a small percentage of the potentially irrigable land in the subbasin.

Of the water sources available, it appears that most of the potentially irrigable land in the subbasin will require storage, while a limited amount can be developed using ground water and Willamette River natural flow. Generally, the lower-lying lands have the alternatives available of being served either by cooperative pumping from the Willamette River or by new storage on the tributaries. Generally, the higher lands can be served only from new storage.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

Irrigation to date in the Coast Range Subbasin has been almost entirely on an individual basis, with only 150 acres irrigated by cooperative means. About 62 percent of the present irrigation is from surface-water supplies. Development has occurred mostly along the Willamette River and to a lesser extent along the major tributaries within the subbasin. Since some additional ground-water resources remain, as well as a potential for additional development of surface water, individual development is expected to continue. However, the lack of adequate water supplies on or near a majority of farms will result in most of the new irrigation being developed through cooperative effort. By 2020, some 310,000 acres are expected to be under irrigation, and the Coast Range Subbasin will lead all other subbasins in irrigated acreage. A major share of the increase is expected to occur between 1980 and 2000, as shown in Table IV-8.

Table IV-8

Projected Irrigation Development by Source of Supply, Subbasin 6 - Coast Range

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	27,420	--	--	16,400	43,820
1980	29,000	3,000	--	20,000	52,000
2000	30,500	5,500	--	25,000	61,000
2020	31,500	8,000	--	25,000	64,500
Cooperative					
1965	150	--	--	--	150
1980	24,000	11,000	46,000	--	81,000
2000	31,000	30,000	140,000	--	201,000
2020	31,000	41,900	172,600	--	245,500
Total					
1965	27,570	--	--	16,400	43,970
1980	53,000	14,000	46,000	20,000	133,000
2000	61,500	35,500	140,000	25,000	262,000
2020	62,500	49,900	172,600	25,000	310,000

Additional individual developments utilizing ground water are expected to occur along the Willamette River and in a few other scattered places. Although additional irrigation from streamflow is not expected along the subbasin's interior streams, diversions will be made from Wil-

lamette River. More farm ponds are also expected to be developed to irrigate new lands in scattered areas of the subbasin.

Cooperative effort will be the primary means for developing irrigation of new lands in this subbasin. Although there is only one small existing irrigation project (150 acres), planning has been completed by Federal agencies on several projects.

The Bureau of Reclamation has completed feasibility reports on two multipurpose projects which are presently awaiting authorization. The Monmouth-Dallas Division will initially serve 17,200 acres and subsequently expand to 28,000 acres, pumping natural flow from Willamette River. The Red Prairie Division is planned to irrigate 15,500 acres south of Sheridan, using storage in a reservoir to be constructed on Mill Creek. Carlton Division on the North Yamhill River would irrigate about 30,000 acres from both new and existing storage; feasibility studies for this development are in progress. See Map IV-2.

The Soil Conservation Service has planning well advanced on eight small watershed projects shown on Map IV-1. These projects are planned to irrigate about 26,000 acres from new small reservoirs, as follows: Chehalem Creek (1,000); Spring Valley (1,700); Palmer Creek (1,200); Salt Creek (4,400); Deer Creek (5,200); Little Luckiamute River (4,000); Soap Creek (1,200); and West Muddy Creek (7,600).

Several additional private community projects, some with Federal assistance, will probably be developed in this subbasin. The Palmer Creek Project will irrigate about 3,500 acres from natural flows of the Willamette River when construction is completed. A considerable potential exists for community development on the benchlands adjacent to Willamette River. These new projects would most likely derive their water supplies from existing Federal storage and supply small areas near the river.

There are several opportunities for large-scale project development. General areas where this is possible have been delineated and contain blocks of land suited to cooperative development (Map IV-2).

South Yamhill area includes about 80,000 potentially irrigable acres within the South Yamhill River drainage system and along the east side of the Eola Hills. Lands in this area could best be supplied from a combination of water sources. It appears that those lands east of Eola Hills will obtain their water supplies from Willamette River. The most economical water source for the remaining lands appears to be new storage on the South Yamhill River or its tributaries. However, it would also be possible to serve part of this area from Willamette River.

Luckiamute area, located in Polk and Benton Counties, contains about 33,000 potentially irrigable acres. The most economical water source for these lands appears to be new storage on Luckiamute River. The only available alternative would be pumping from the Willamette River to serve a part of these lands.

Adair area, located in Benton County near Corvallis and Albany, contains about 14,000 potentially irrigable acres. The most economical source of water for this area is the Willamette River, where upstream storage could be utilized. Reconnaissance studies by the Bureau of Reclamation indicate that a project to serve lands in this area is economically feasible. No feasible alternative source appears available to the Adair area, although it is physically possible to bring water from Luckiamute and Marys Rivers.

Marys River area, located immediately west of Corvallis, contains about 18,000 potentially irrigable acres. The most economical source of water for this area appears to be new storage on Marys River. As an alternative, it is also possible to pump from the Willamette River to serve a part of the area.

West Long Tom area, located in Benton County between Monroe and Corvallis, contains about 26,000 potentially irrigable acres. The most economical source of water for these lands appears to be Long Tom River, utilizing releases from upstream storage. Reconnaissance studies by the Bureau of Reclamation indicate that a project to serve lands in this area is economically feasible. A possible alternative would be pumping from the Willamette River.

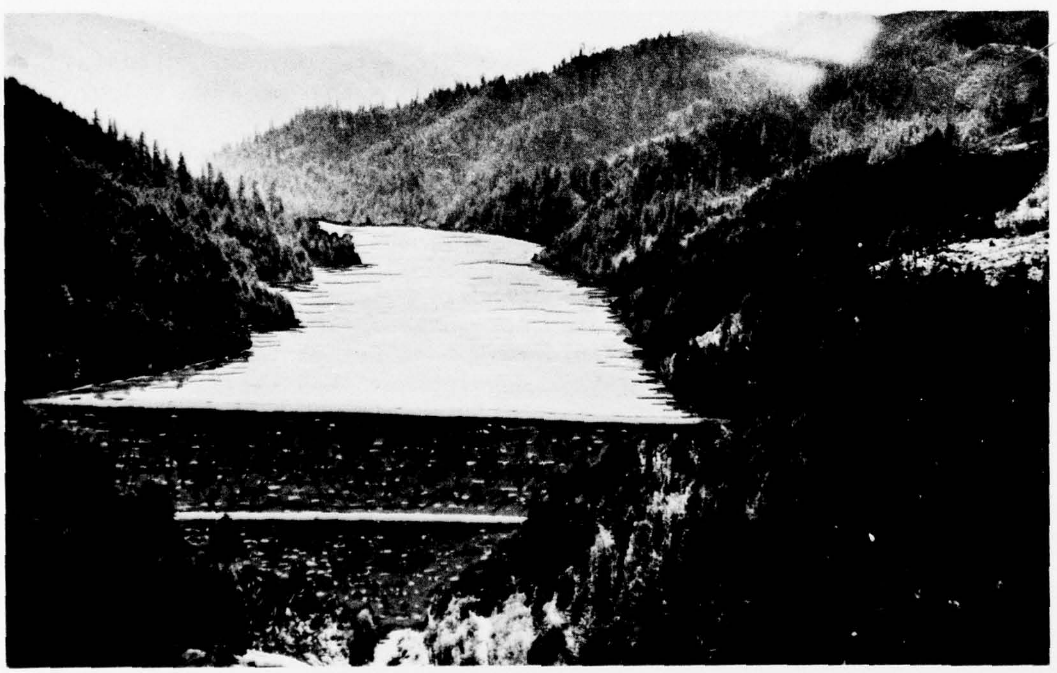


Photo IV-4. Artist's conception of Gorge reservoir, Red Prairie Division. Plans for this multipurpose project include irrigating 15,500 acres south of Sheridan. (Source: U.S. Bureau of Reclamation)

S U B B A S I N 7 - P U D D I N G

Abundant supplies of ground water make this subbasin unique among the subbasins of the Willamette. Already, 33,700 acres are irrigated from wells, more than in any other subbasin. However, additional development of surface water will be required to meet the projected annual water demand for irrigation of over 600,000 acre-feet by 2020.

SOURCES OF WATER

Pudding Subbasin interior streams are heavily appropriated during the irrigation season. Many of these streams are not even able to fully supply the rights presently in force. Therefore, it appears that very little additional irrigation can be supplied from natural flow. Upstream storage on the Willamette system, however, could be used in this subbasin. Therefore, it is expected that additional irrigation development will be based on ground water, existing upstream storage, and new storage.

The Pudding Subbasin contains perhaps the best ground-water reservoir in the Willamette Basin. The French Prairie area, which comprises a large part of the potentially irrigable lands in the northwest sector of the subbasin, has a ground-water supply which could support irrigation pumpage at several times the present rate. The same situation exists on the recent alluvium along the Willamette River. In the remainder of the subbasin, ground-water resources are generally inadequate to support any sizable irrigation development.

At present, the subbasin does not contain any storage reservoirs. Some lands could be served by diverting from the Willamette or North Santiam River, using water stored in one or more of the large upstream Federal reservoirs. In addition, a number of promising storage sites exist within the subbasin.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

Nearly 90 percent of the presently irrigated lands in the subbasin have been developed on an individual basis. Cooperative development is expected to provide the majority of new irrigation and will use existing and new storage almost entirely. Additional individual developments will occur through the expanded use of streamflow, farm ponds, and particularly ground water. See Table IV-9.

Additional individual developments are expected to occur in the French Prairie area from ground water, along the Willamette from both ground water and streamflow, and in scattered areas of the subbasin from new farm ponds. By 2020, about 60 percent of the irrigated acreage in the subbasin will be developed by individual effort, and three-fourths of the acreage in individual developments will be irrigated from ground-water supplies.

Table IV-9

Projected Irrigation Development by Source of Supply
Subbasin 7 - Pudding

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	30,570	--	--	33,680	64,250
1980	32,000	1,000	--	42,400	75,400
2000	33,300	1,600	--	88,500	123,400
2020	33,700	3,500	--	109,200	146,400
Cooperative					
1965	8,500	--	--	--	8,500
1980	9,000	11,000	8,600	--	28,600
2000	9,000	35,300	48,300	--	92,600
2020	9,000	42,900	59,700	--	111,600
Total					
1965	39,070	--	--	33,680	72,750
1980	41,000	12,000	8,600	42,400	104,000
2000	42,300	36,900	48,300	88,500	216,000
2020	42,700	46,400	59,700	109,200	258,000

Many of the subbasin's potentially irrigable lands are located such that individual development is not practical. Development of these lands is expected to occur on a cooperative basis, using both existing and new storage. At present, several cooperative developments irrigate about 9,000 acres from natural flows, but significant expansion of these facilities will require use of storage. Farmers in this subbasin have displayed considerable interest in cooperative Federal irrigation programs, and currently the Bureau of Reclamation and the Soil Conservation Service have extensive planning underway.

The Bureau of Reclamation is making a feasibility study of the subbasin to determine a plan for multipurpose water resource development. Irrigation alternatives being considered are new large storage reservoirs on Molalla River, Butte Creek, Silver Creek, and Pudding River; use of existing irrigation storage in Detroit Reservoir by diverting from the North Santiam River; pumping from Willamette River; and developing ground water. The subbasin plan could incorporate all of these water sources because of the extent of irrigation potential in the subbasin.

Preliminary studies indicate the French Prairie area is most favorably suited to service from ground water. The Molalla Slope area, immediately to the east, is best suited to service from new storage reservoirs. The area generally south of Silverton, including Howell Prairie, Shaw, and Waldo Hills, could best be served by releases from Detroit Reservoir.

The Soil Conservation Service also has programs underway in this subbasin. The Beaver Creek Project is now under construction, and when complete could irrigate up to 3,500 acres between Stayton and Turner. Also, the Drift Creek and Butte Creek watershed projects, now under study, would provide water to irrigate about 7,200 acres (Map IV-1).

In total, some 112,000 acres are expected to be developed through group effort by 2020, with more than 60 percent of the increase occurring between 1980 and 2000.

The alternatives for cooperative development in this subbasin consist primarily of varying the amount of water obtained from new storage and/or existing storage. Also, parts of the French Prairie area might be served more economically from Willamette River than from ground water.

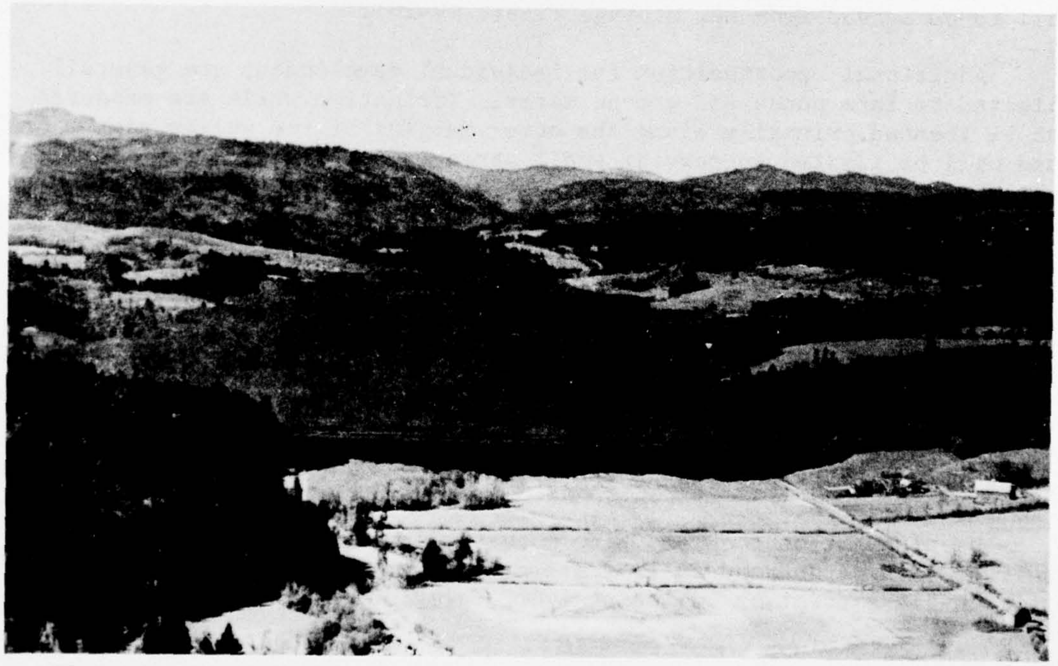


Photo IV-5. Artist's conception of Scoggins reservoir, Tualatin Project. This multipurpose project will irrigate 17,000 acres of lands in subbasin 8. (Source: U.S. Bureau of Reclamation)

SUBBASIN 8 - TUALATIN

Because of its proximity to rapidly expanding metropolitan Portland, the Tualatin Subbasin is estimated to reach a peak irrigation development of 74,000 acres by the year 2000, and then decline. To meet this peak need, over 200,000 acre-feet of water will be required annually.

SOURCES OF WATER

The Tualatin River is one of the few rivers in the basin which has been adjudicated. Further use of natural flow is not expected because existing water rights control nearly all of the irrigation season natural flow. Five minor streams have been closed to further appropriation, except from storage, by the Oregon State Engineer. Future development will depend primarily on storage and to a minor degree on ground water. New storage developments will be required to meet the projected future needs.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All irrigation developed thus far has been on an individual basis, with surface water supplying nearly all lands. Future irrigation development is expected to be accomplished primarily by cooperative efforts. The most significant expansion of irrigation will occur between 1980 and 2000, with the development of an estimated 31,000 acres -- nearly all to be served from new storage (Table IV-10).

Additional opportunities for individual development are generally limited to farm ponds and ground water. Irrigation wells are expected to be located primarily along the outer margins of the valley plains and will be limited to serving small acreages. Irrigation from surface water on an individual basis is expected to decrease by 2020 in spite of the new farm pond development.

Cooperative development appears to be the only practical means for supplying irrigation water to the bulk of the potentially irrigable land in the subbasin. The Tualatin Project, which is authorized for construction by the Bureau of Reclamation, will supply water from new storage on Scoggins Creek to irrigate 17,000 acres (Map IV-2). In addition, the McKay-Rock Creek Project, recommended by the Soil Conservation Service for authorization, would supply water to irrigate 5,000 to 6,000 acres from new storage reservoirs.

Development of the remaining potentially irrigable land lends itself to both large- and small-scale storage projects. Promising large storage sites exist on Tualatin River, Gales Creek, and East Fork Dairy Creek.

Bureau of Reclamation feasibility studies are scheduled to get underway in Fiscal Year 1970 on the second phase of the Tualatin Project. Preliminary plans indicate that this multipurpose development could bring some 25,000 to 30,000 acres under irrigation.

Table IV-10

Projected Irrigation Development by Source of Supply
Subbasin 8 - Tualatin

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	17,890	--	--	1,200	19,090
1980	17,800	--	--	2,200	20,000
2000	17,000	--	--	3,600	20,600
2020	15,000	--	--	3,400	18,400
Cooperative					
1965	--	--	--	--	--
1980	--	--	23,000	--	23,000
2000	--	--	53,400	--	53,400
2020	--	--	49,600	--	49,600
Total					
1965	17,890	--	--	1,200	19,090
1980	17,800	--	23,000	2,200	43,000
2000	17,000	--	53,400	3,600	74,000
2020	15,000	--	49,600	3,400	68,000

Many small reservoir sites are also available in the subbasin. The Soil Conservation Service is studying the West Fork Dairy Creek and East Fork Dairy Creek watershed projects (Map IV-1). An estimated 5,500 acres are planned to be irrigated from these projects.

An alternative, though unlikely, would involve diversion from either the main stem Willamette River or Multnomah Channel and pumping to some of the subbasin's lands. These plans would require relatively high pump lifts and long pipelines.

S U B B A S I N 9 - C L A C K A M A S

Although endowed with an abundant supply of water and a sizable area of potentially irrigable land, Clackamas Subbasin is not expected to realize any substantial expansion of irrigation development. The major deterrent will be a progressive reduction in the irrigable land base. About 65 percent of the lands suitable for irrigation are expected to be lost to urban encroachment by 2020.

SOURCES OF WATER

The South Fork Clackamas River and Memaloos Creek were withdrawn from appropriation for other than municipal uses by the Oregon State Engineer in 1931. In addition, the Oregon State Engineer has ordered no further appropriation, except from storage, on three other minor streams. On the main stem of the Clackamas River, however, the possibility exists that some natural flow is available during the irrigation season. Ground water is plentiful throughout the lower areas of the subbasin, but in some instances lies at such great depths as to be very costly for irrigation.

The major reservoirs in the subbasin are owned and operated by Portland General Electric Company for power purposes. Upstream Federal storage on the Willamette River can be utilized to irrigate some of the more favorably located lands along the river. Also, it would be possible to divert stored water from proposed new reservoirs on the Molalla River into the Clackamas Subbasin.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All presently irrigated lands have been developed by individual effort, largely from surface water supplies. Future irrigation development is expected to occur through both individual and cooperative efforts. By 2020, over 60 percent of the total development will be through individual effort. Table IV-11, a summary of projected irrigation development, shows that the water supplies for future irrigation will come largely from ground water, natural flows, and new storage.

Additional irrigation by individuals will be based primarily on the use of ground water and is expected to occur in the lower part of the subbasin. The remainder will probably utilize new farm ponds scattered throughout the lands lying at higher elevations.

There are no lands being irrigated by community projects, nor is any such development anticipated in this subbasin until after 1980. The majority of the potentially irrigable lands are scattered and considerably elevated above the sources of surface water. Reconnaissance studies by the Bureau of Reclamation show that opportunities for large-scale irrigation development in most of the subbasin are remote due to high pump lifts and expensive distribution systems. An exception occurs in the area south of Oregon City between the Willamette River and Abernathy Creek. The western part of this area is adjacent to Willamette River and sufficiently low that a pumping plant on the river could serve

Table IV-11

Projected Irrigation Development by Source of Supply
Subbasin 9 - Clackamas

Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
Individual					
1965	4,230	--	--	2,100	6,330
1980	4,700	--	--	2,300	7,000
2000	6,500	--	--	6,000	12,500
2020	7,200	--	--	8,300	15,500
Cooperative					
1965	--	--	--	--	--
1980	--	--	--	--	--
2000	--	2,500	7,000	--	9,500
2020	--	2,500	7,000	--	9,500
Total					
1965	4,230	--	--	2,100	6,330
1980	4,700	--	--	2,300	7,000
2000	6,500	2,500	7,000	6,000	22,000
2020	7,200	2,500	7,000	8,300	25,000

the area economically. The eastern part of this area is higher in elevation, but due to its proximity to lands in the Pudding Subbasin where large new storage projects are anticipated, it could probably be added to a project in that subbasin. Based on these potentials, it is expected that by 2020 irrigation facilities will have been constructed through group effort for 2,500 acres utilizing upstream storage on the Willamette system and for 3,000 acres using new storage in the Pudding Subbasin.

The remainder of the subbasin could probably best be irrigated by new small storage projects. Smaller streams appear to offer the greatest opportunity for these developments. It is predicted that by 2020, 4,000 acres will be irrigated in this manner.

In the western block of lands between the Willamette River and Abernathy Creek, an alternative would be to supply the entire area from new storage reservoirs in the Pudding Subbasin. Other potentially irrigable lands to the east and near the Clackamas River might obtain water by high lift pumping from the Clackamas River or from one of the power development reservoirs on the river.

S U B B A S I N 1 0 - C O L U M B I A

The Columbia Subbasin contains 33,590 acres of potentially irrigable land plus 10,760 acres of irrigated land. However, because of its proximity to the rapidly expanding Portland metropolitan area, it is expected that by year 2000, urban encroachment will have converted all of the irrigated and potentially irrigable land to nonagricultural uses, thereby eliminating the need for irrigation water.

SOURCES OF WATER

Scappoose Creek, Johnson Creek and its tributaries, McNulty Creek and its tributaries, and Milton Creek and its tributaries have all been withdrawn from further irrigation appropriations by the Oregon State Legislature. In most cases, however, appropriations to store water are allowed during the winter months or periods of high runoff.

Ground-water potential is excellent on Sauvie Island and in the lowlands to the west along Multnomah Channel. The alluvial deposits and underlying Troutdale Formation are capable of yielding from 1,000 to 1,500 gallons per minute to individual wells. Only a fraction of the potential is now being used. Also, water is available from the Columbia and Willamette Rivers.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All present irrigation is the result of individual efforts. Because of the expected urban encroachment, any new irrigation development in the subbasin will be minimal and relatively temporary. Considering the legal restrictions presently in effect on most of the tributary streams, ground water or pumping from the Columbia River appear to be the most logical sources for any new development that may occur. Table IV-12 shows the projected irrigation development and source of supply.

Table IV-12

Projected Irrigation Development by Source of Supply
Subbasin 10 - Columbia

Individual Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
1965	8,310	--	--	2,450	10,760
1980	6,000	--	--	2,000	8,000
2000	--	--	--	--	--
2020	--	--	--	--	--

S U B B A S I N 11 - S A N D Y

The potential for additional irrigation in the Sandy Subbasin is limited. It is projected that only 7,000 acres will be irrigated by 2020, requiring the diversion of 18,900 acre-feet of water annually.

SOURCES OF WATER

The Oregon State Legislature and the State Water Resources Board have withdrawn all of the surface waters of the subbasin from further irrigation appropriation except the tributaries to the lower reaches of Sandy River. These tributaries have meager irrigation season runoff. Therefore, future irrigation development will depend on the use of ground water, storage of surplus winter runoff in farm ponds, or pumping out of the Columbia River. There is no existing Federal irrigation storage in the subbasin.

PROBABLE DEVELOPMENT AND MAJOR ALTERNATIVES

All irrigation developed thus far has been on an individual basis. Some 900 acres are supplied from ground water and 940 acres from surface sources. It is expected that all future development will be on an individual basis and will be supplied from ground water, natural flows, and farm ponds (Table IV-13).

The flood plain alluvium along the Columbia River in the Sandy Subbasin yields from several hundred to more than 1,000 g.p.m. to wells tapping its lower depths. Most of the water-bearing sand and gravel layers occur deeper than 100 feet. On-farm pumping from wells or directly from the Columbia River by individuals would be practical in this area.

Ground water and natural flows are not generally available in sufficient quantities to serve as a source of irrigation water throughout the remainder of the subbasin. Consequently, individual development will be limited to farm ponds in this area.

Table IV-13

Projected Irrigation Development by Source of Supply
Subbasin 11 - Sandy

Individual Development	Natural Flow and Farm Ponds (acres)	Existing Storage (acres)	New Storage (acres)	Ground Water (acres)	Total (acres)
1965	940	--	--	900	1,840
1980	900	--	--	1,100	2,000
2000	1,600	--	--	2,400	4,000
2020	3,200	--	--	3,800	7,000

CONCLUSIONS

CONCLUSIONS

Although the Willamette Basin is blessed with abundant rainfall, the adverse seasonal distribution is a serious deterrent to optimum agricultural production. To realize the full potential for agricultural production, further development of irrigation will be a vital factor.

Irrigation in the Willamette Basin developed slowly during the first part of the century, reaching 27,000 acres by 1940. After the end of World War II, development accelerated with the advent of lightweight sprinkler pipe, and by 1965 nearly a quarter of a million acres were under irrigation. Progress has been made primarily through individual efforts with only about 10 percent being developed by cooperative means.

Irrigation contributes substantially to the agricultural economy. Less than 10 percent of the lands in farms are irrigated, but are responsible for over one-third of the total value of all agricultural production. The basin is well known not only for its high quality vegetables and fruit, but for production of high-value seed crops as well. With irrigation, farmers have greater freedom to choose and diversify their crops, to substantially increase their crop quality and yield, and to significantly reduce the danger of crop failure.

The potential for irrigation expansion in the Willamette Basin is highly favorable. Abundant water supplies of excellent quality, over 1-1/2 million acres of fertile land well suited for irrigation development, a favorable climate for production of a wide variety of irrigated crops, and a favorable economic and social environment are all conducive to growth of irrigation.

Irrigation development is expected to accelerate in the next three decades and then continue at a slower pace, reaching about 1,000,000 acres by 2020. By that time, nearly three-fourths of the remaining irrigable land will be irrigated, requiring an annual water diversion or withdrawal of nearly 2.5 million acre-feet. Of this, about 1.6 million acre-feet will be utilized in crop production, while the remainder will return to streams and ground-water reservoirs. Nearly 80 percent of the irrigation water will be supplied from surface sources, the remainder from ground-water aquifers.

By 1980, an estimated 186,000 additional acres will be irrigated, bringing the total to about 430,000 acres. It is expected that 15 to 20 percent of the additional development will be by individual effort and will take place primarily along major streams and in high yielding ground-water areas. The remaining 80 to 85 percent will of necessity be developed on a project basis. Federal projects showing promise of being developed by 1980 or shortly thereafter are the Tualatin, Monmouth-Dallas, Carlton, and Red Prairie projects (totaling about 80,000 acres) by the Bureau of Reclamation, and the Federally assisted Lower Amazon-Flat Creek, McKay-Rock Creek, and Beaver Creek, plus 19 other small watershed projects (totaling about 60,000 acres) by the Soil Conservation Service.

Most streams will not support additional irrigation use from natural flows during the low flow season; however, ground-water supplies plus existing and new storage reservoirs can meet the projected needs. Presently only 1 percent of the more than one million acre-feet of storage assigned to irrigation in the system of 14 existing and authorized Federal reservoirs is being used; however, use of this storage is expected to increase sharply. New storage also will be required to serve lands which, due to location, cannot be economically supplied from existing reservoirs. However, care should be taken to avoid investing Federal funds in new reservoirs to irrigate lands which can be supplied equally well from existing storage or from groundwater.

Consideration should be given to a redistribution of storage presently assigned to irrigation in the 14-Federal-reservoir system. An evolving situation, created primarily by extensive use of natural flows and ground water on lands previously expected to irrigate from Federal storage has resulted in a smaller projected use of this storage. It appears that only 75 to 80 percent of the present irrigation allocation will be in use when peak irrigation development is reached sometime after year 2020. Consequently, an opportunity exists to reallocate some of the existing storage to other functions without detriment to future irrigation needs. However, particular care should be taken to reserve full storage rights on certain reservoirs which have locational advantages.

State water right regulation could have a profound bearing on the amount of storage needed for future irrigation. Adjudication of all basin streams is needed to clarify the status of claims to water prior to 1909. There is an accelerating need to strengthen and facilitate the enforcement of the State's water right program since most of the natural flow of basin streams is committed to existing uses. Future development requiring a reliable water supply will be dependent on reservoir storage, together with careful administration of the entire water resource.

The irrigation plan for Willamette Basin as well as an analysis of the effects of the comprehensive plan on irrigation are presented in Appendix M, Plan Formulation.

Irrigated Crops